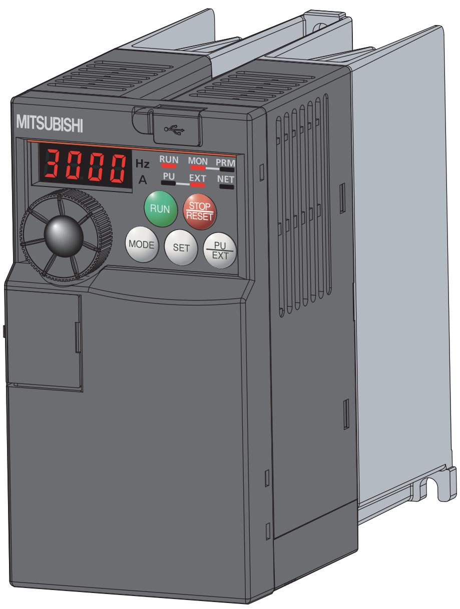
MITSUBISHI ELECTRIC

SENSORLESS SERVO DRIVE UNIT FR-E700EX

INSTRUCTION MANUAL (Applied)

FR-E720EX-0.1K to 3.7K

According to the motor to be connected, perform PM parameter initialization. Incorrect initial setting of parameters may damage the motor. *(Refer to page 73)*
In the initial setting, FR-E720EX-0.1K to 0.75K is set for an MM-GKR motor, and FR-E720EX-1.5K to 3.7K is set for an S-PM geared motor.
Only use a motor that is a dedicated PM motor (MM-GKR motor or S-PM geared motor).



Thank you for choosing this Mitsubishi Sensorless servo drive unit.

This Instruction Manual (Applied) provides instructions for advanced use of the FR-E700EX series drive units.

Incorrect handling might cause an unexpected fault. Before using the drive unit, always read this Instruction Manual and the instruction manual (Basic) [IB-0600506ENG] packed with the product carefully to use the equipment to its optimum performance.

This section is specifically about safety matters

Do not attempt to install, operate, maintain or inspect the drive unit until you have read through the Instruction Manual and appended documents carefully and can use the equipment correctly. Do not use this product until you have a full knowledge of the equipment, safety information and instructions.

In this Instruction Manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

⚠WARNING	Incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠CAUTION	Incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause only material damage.

The ⚠CAUTION level may even lead to a serious consequence according to conditions. Both instruction levels must be followed because these are important to personal safety.

1. Electric Shock Prevention

⚠WARNING

- While the drive unit power is ON, do not open the front cover or the wiring cover. Do not run the drive unit with the front cover or the wiring cover removed. Otherwise you may access the exposed high voltage terminals or the charging part of the circuitry and get an electric shock.
- Even if power is OFF, do not remove the front cover except for wiring or periodic inspection. You may accidentally touch the charged drive unit circuits and get an electric shock.
- Before wiring or inspection, power must be switched OFF. To confirm that, LED indication of the operation panel must be checked. (It must be OFF.) Any person who is involved in wiring or inspection shall wait for at least 10 minutes after the power supply has been switched OFF and check that there are no residual voltage using a tester or the like. The capacitor is charged with high voltage for some time after power OFF, and it is dangerous.
- This drive unit must be earthed (grounded). Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 536 class 1 and other applicable standards).
- Any person who is involved in wiring or inspection of this equipment shall be fully competent to do the work.
- The drive unit must be installed before wiring. Otherwise you may get an electric shock or be injured.
- Setting dial and key operations must be performed with dry hands to prevent an electric shock.
- Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Otherwise you may get an electric shock.
- Do not change the cooling fan while power is ON. It is dangerous to change the cooling fan while power is ON.
- Do not touch the printed circuit board or handle the cables with wet hands. Otherwise you may get an electric shock.
- When measuring the main circuit capacitor capacity, the DC voltage is applied to the motor for 1s at powering OFF. Never touch the motor terminal, etc. right after powering OFF to prevent an electric shock.
- A PM motor is a synchronous motor with embedded magnets. High-voltage is generated at motor terminals while the motor is running even after the drive unit power is turned OFF. Before wiring or inspection, the motor must be confirmed to be stopped. For applications where the motor is driven by the load, the low-voltage manual contactor, which is installed at the drive unit's output side, must be opened before wiring or inspection. Otherwise you may get an electric shock. Do not use a magnetic contactor at the drive unit's output side.

2. Fire Prevention

⚠CAUTION

- Drive unit must be installed on a nonflammable wall without holes (so that nobody touches the drive unit heatsink on the rear side, etc.). Mounting it to or near flammable material can cause a fire.
- If the drive unit has become faulty, the drive unit power must be switched OFF. A continuous flow of large current could cause a fire.
- When using a brake resistor, a sequence that will turn OFF power when a fault signal is output must be configured. Otherwise the brake resistor may overheat due to damage of the brake transistor and possibly cause a fire.
- Do not connect a resistor directly to the DC terminals P/+ and N/-. Doing so could cause a fire.
- Daily and periodic inspections must be performed as instructed in the Instruction Manual. If the product is used without receiving any inspection, it may cause a burst, break, or fire.

3.Injury Prevention

⚠CAUTION

- The voltage applied to each terminal must be the ones specified in the Instruction Manual. Otherwise burst, damage, etc. may occur.
- The cables must be connected to the correct terminals. Otherwise burst, damage, etc. may occur.
- Polarity must be correct. Otherwise burst, damage, etc. may occur.
- While power is ON or for some time after power-OFF, do not touch the drive unit as they will be extremely hot. Doing so can cause burns.

4. Additional Instructions

Also the following points must be noted to prevent an accidental failure, injury, electric shock, etc.

(1) Transportation and Mounting

⚠CAUTION

- The product must be transported in correct method that corresponds to the weight. Failure to do so may lead to injuries.
- Do not stack the boxes containing drive units higher than the number recommended.
- The product must be installed to the position where withstands the weight of the product according to the information in the Instruction Manual.
- Do not install or operate the drive unit if it is damaged or has parts missing.
- When carrying the drive unit, do not hold it by the front cover or setting dial; it may fall off or fail.
- Do not stand or rest heavy objects on the product.
- The drive unit mounting orientation must be correct.
- Foreign conductive objects must be prevented from entering the drive unit. That includes screws and metal fragments or other flammable substance such as oil.
- As the drive unit is a precision instrument, do not drop or subject it to impact.
- The drive unit must be used under the following environment. Otherwise the drive unit may be damaged.

Environment	Surrounding air temperature	-10°C to +50°C (non-freezing)
	Ambient humidity	90%RH or less (non-condensing)
	Storage temperature	-20°C to +65°C *
	Atmosphere	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
	Altitude/ vibration	Maximum 1,000m above sea level. 5.9m/s^2 or less at 10 to 55Hz (directions of X, Y, Z axes

*Temperature applicable for a short time, e.g. in transit.

- If halogen-based materials (fluorine, chlorine, bromine, iodine, etc.) infiltrate into a Mitsubishi product, the product will be damaged. Halogen-based materials are often included in fumigant, which is used to sterilize or disinfest wooden packages. When packaging, prevent residual fumigant components from being infiltrated into Mitsubishi products, or use an alternative sterilization or disinfection method (heat disinfection, etc.) for packaging. Sterilization of disinfection of wooden package should also be performed before packaging the product.

(2) Wiring

⚠CAUTION

- Do not install a power factor correction capacitor or surge suppressor/capacitor type filter on the drive unit output side. These devices on the drive unit output side may be overheated or burn out.
- Correctly connect the output side terminals (terminals U, V, and W).
- PM motor terminals (U, V, W) hold high-voltage while the PM motor is running even after the power is turned OFF. Before wiring, the PM motor must be confirmed to be stopped. Otherwise you may get an electric shock.
- Never connect a PM motor to the commercial power supply. Applying the commercial power supply to input terminals (U, V, W) of a PM motor will burn the PM motor. The PM motor must be connected with the output terminals (U, V, W) of the drive unit.

(3) Trial run

⚠CAUTION

- Before starting operation, each parameter must be confirmed and adjusted. A failure to do so may cause some machines to make unexpected motions.

(4) Usage

⚠WARNING

- A PM motor and the drive unit must be used in the specified capacity combination.
- Only one PM motor can be connected to a drive unit.
- Any person must stay away from the equipment when the retry function is set as it will restart suddenly after trip.
- Since pressing STOP RESET key may not stop output depending on the function setting status, separate circuit and switch that make an emergency stop (power OFF, mechanical brake operation for emergency stop, etc.) must be provided.
- OFF status of the start signal must be confirmed before resetting the drive unit fault. Resetting drive unit alarm with the start signal ON restarts the motor suddenly.
- Do not modify the equipment.
- Do not perform parts removal which is not instructed in this manual. Doing so may lead to fault or damage of the product.

⚠CAUTION

- The electronic thermal relay function does not guarantee protection of the motor from overheating. It is recommended to install both an external thermal and PTC thermistor for overheat protection.
- Do not use a magnetic contactor on the drive unit input for frequent starting/stopping of the drive unit. Otherwise the life of the drive unit decreases.
- The effect of electromagnetic interference must be reduced by using a noise filter or by other means. Otherwise nearby electronic equipment may be affected.
- Appropriate measures must be taken to suppress harmonics. Otherwise power supply harmonics from the drive unit may heat/damage the power factor correction capacitor and generator.
- When parameter clear or all parameter clear is performed, the required parameters must be set again before starting operations because all parameters return to the initial value.
- The drive unit can be easily set for high-speed operation. Before changing its setting, the performances of the motor and machine must be fully examined.
- Stop status cannot be hold by the drive unit's brake function. In addition to the drive unit's brake function, a holding device must be installed to ensure safety.
- Before running a drive unit which had been stored for a long period, inspection and test operation must be performed.
- Static electricity in your body must be discharged before you touch the product. Otherwise the product may be damaged.
- Do not use a PM motor in an application where a motor is driven by its load and runs at a speed higher than the maximum motor speed.
- According to the motor to be connected, perform PM parameter initialization. Incorrect initial setting of parameters may damage the motor.
  In the initial setting, FR-E720EX-0.1K to 0.75K is set for an MM-GKR motor, and FR-E720EX-1.5K to 3.7K is set for an S-PM geared motor.
  Only use a motor that is a dedicated PM motor (MM-GKR motor or S-PM geared motor).
- In the system with a PM motor, the drive unit power must be turned ON before closing the contacts of the contactor at the output side.

(5) Emergency stop

⚠CAUTION

- **A safety backup such as an emergency brake must be provided to prevent hazardous condition to the machine and equipment in case of drive unit failure.**
- **When the breaker on the drive unit input side trips, the wiring must be checked for fault (short circuit), and internal parts of the drive unit for a damage, etc. The cause of the trip must be identified and removed before turning ON the power of the breaker.**
- **When any protective function is activated, appropriate corrective action must be taken, and the drive unit must be reset before resuming operation.**

(6) Maintenance, inspection and parts replacement

⚠CAUTION

- **Do not carry out a megger (insulation resistance) test on the control circuit of the drive unit. It will cause a failure.**

(7) Disposal

⚠CAUTION

- **The drive unit must be treated as industrial waste.**

General instruction

Many of the diagrams and drawings in this Instruction Manual show the drive unit without a cover or partially open for explanation. Never operate the drive unit in this manner. The cover must be always reinstalled and the instruction in this Instruction Manual must be followed when operating the drive unit.
For more details on a dedicated PM motor, refer to the Instruction Manual of the dedicated PM motor and the sensorless servo catalog.

CONTENTS

MEMO

1 OUTLINE

**This chapter explains the "OUTLINE" for use of this product.
Always read the instructions before using the equipment.**

<Abbreviations>
- PU: Operation panel and parameter unit (FR-PU07)
- Drive unit: Mitsubishi sensorless servo drive unit FR-E700EX series
- FR-E700EX: Mitsubishi sensorless servo drive unit FR-E700EX series
- Pr.: Parameter number (Number assigned to function)
- PU operation: Operation using the PU (operation panel/FR-PU07)
- External operation: Operation using the control circuit signals
- Combined operation: Operation using both the PU (operation panel/FR-PU07) and External operation
- PM motor, motor: MM-GKR motor or S-PM geared motor (dedicated magnet motor)
- The parameters available for each motor are shown using these marks in the following explanation. (Parameters without any mark are valid for all motors.)

MM-GKR motor	S-PM geared motor
GKR	S-PM

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<Mark>

REMARKS: Additional helpful contents and relations with other functions are written.

NOTE: Contents requiring caution or cases when set functions are not activated are written.

POINT: Useful contents and points are written.

Parameters referred to: Related parameters are stated.

<Notes on descriptions in this Instruction Manual>
- Connection diagrams in this Instruction Manual suppose that the control logic of the input terminal is the sink logic, unless otherwise specified. (For the control logic, refer to *page 21*.)

Harmonic suppression guideline (when drive units are used in Japan)
All models of general-purpose drive units used by specific consumers are covered by "Harmonic suppression guideline for consumers who receive high voltage or special high voltage". (For further details, refer to *page 39*.)

1.1 Product checking and parts identification

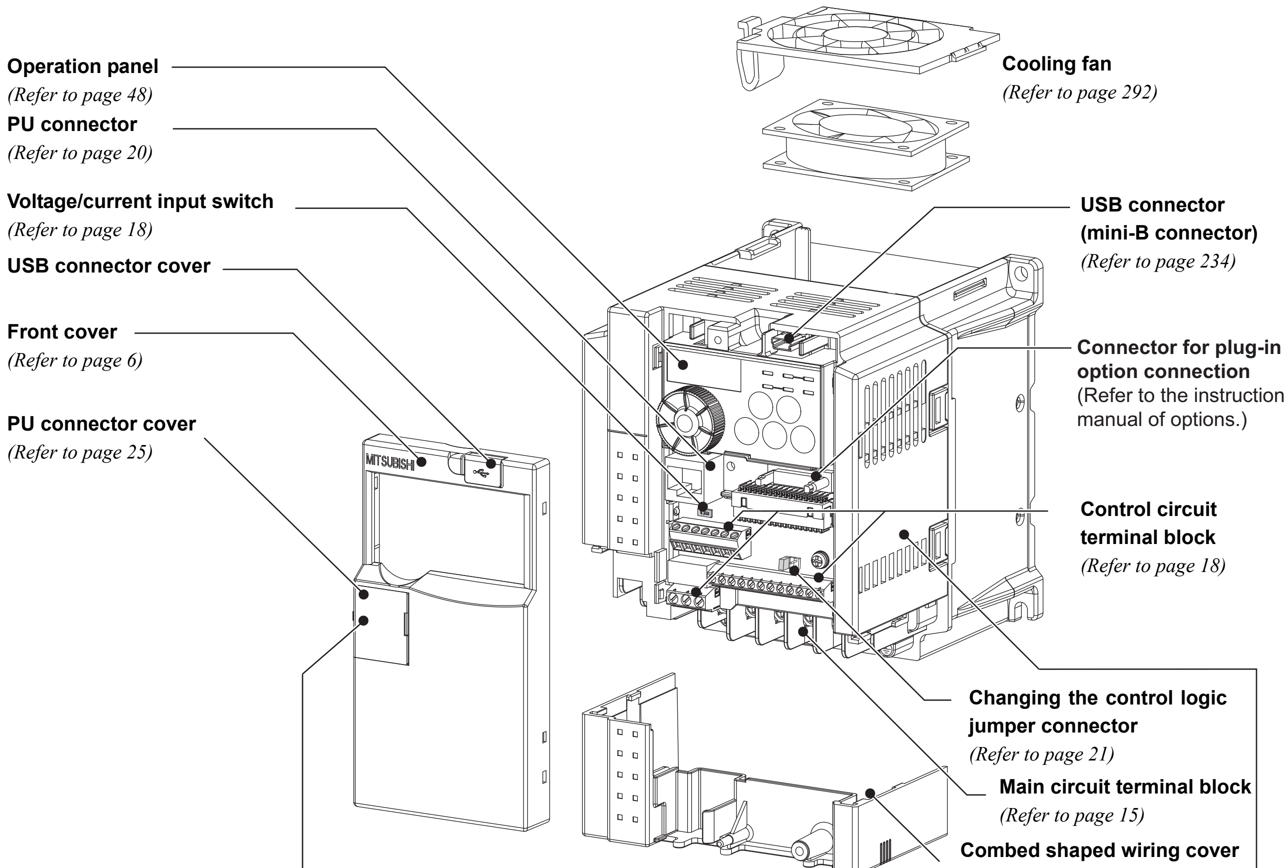
Unpack the drive unit and check the capacity plate on the front cover and the rating plate on the drive unit side face to ensure that the product agrees with your order and the drive unit is intact.

●Drive unit model

FR - E720EX - 1.5 K

Symbol	Voltage class
E720EX	Three-phase 200V class

1.5: Represents the drive unit capacity [kW]



Example of FR-E720EX-1.5K

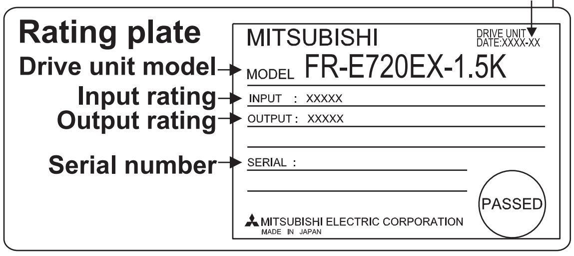
Capacity plate

FR-E720EX-1.5K ←Drive unit model

SERIAL : XXXXXX ←Serial number

∗ For the location of the capacity plate and rating plate, refer to the outline dimension. *(Refer to page 305)*

Production year and month



●Accessory

- Fan cover fixing screws (FR-E720EX-1.5K to 3.7K)(M3×35mm)...1
  These screws are necessary for compliance with the EU Directive. *(Refer to Instruction Manual (Basic))*

●How to read SERIAL

Check the SERIAL number indicated on the drive unit rating plate or package.

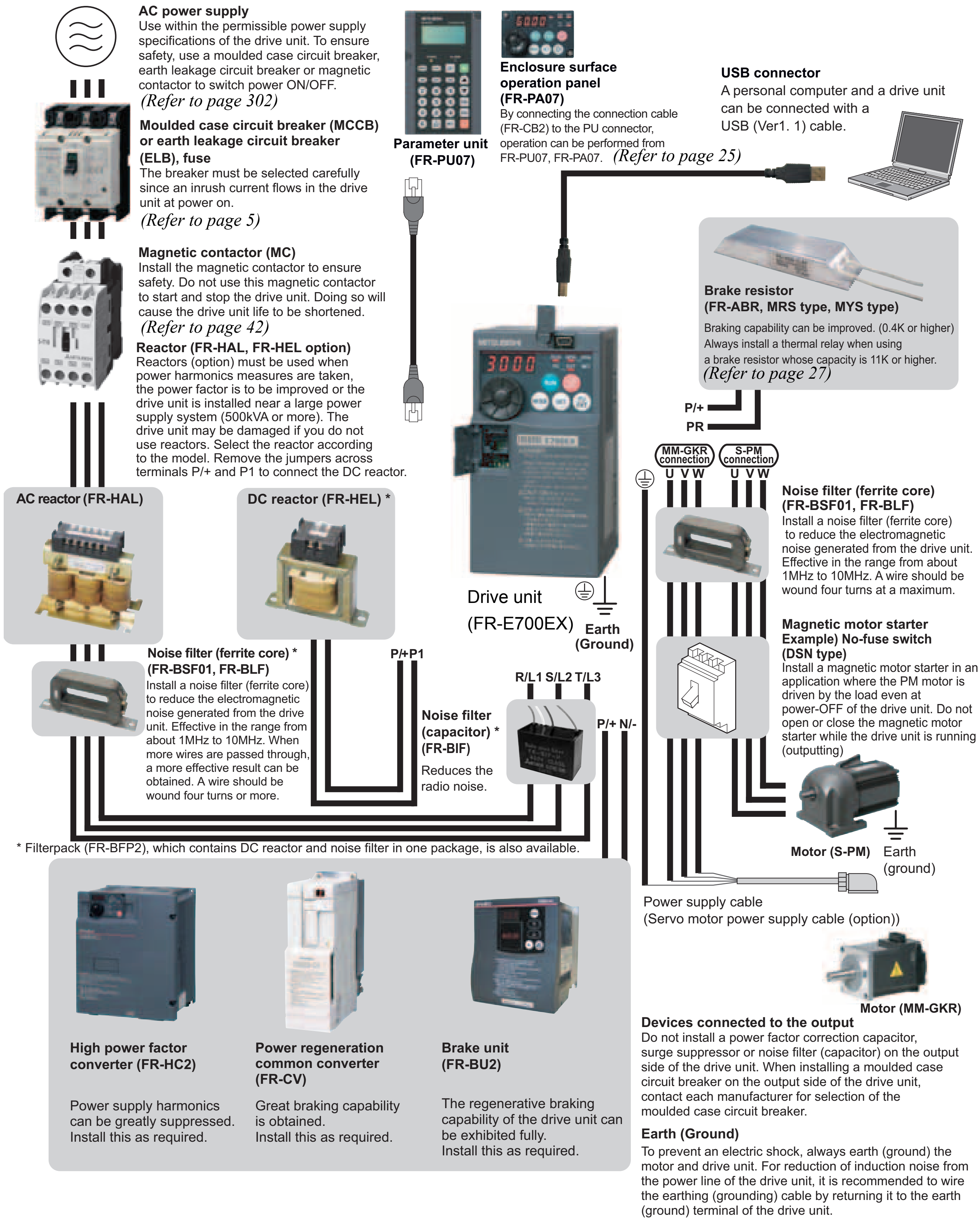
Rating plate example

□	○	○	○○○○○○
Symbol	Year	Month	Control number

SERIAL (Serial No.)

The SERIAL consists of 1 version symbol, 2 numeric characters or 1 numeric character and 1 alphabet letter indicating year and month, and 6 numeric characters indicating control number.
Last digit of the production year is indicated as the Year, and the Month is indicated by 1 to 9, X (October), Y (November), and Z (December).

1.2 Drive unit and peripheral devices



NOTE

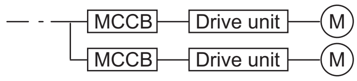
- **The life of the drive unit is influenced by surrounding air temperature. The surrounding air temperature should be as low as possible within the permissible range. This must be noted especially when the drive unit is installed in an enclosure.** *(Refer to page 7)*
- **Wrong wiring might lead to damage of the drive unit. The control signal lines must be kept fully away from the main circuit to protect them from noise.** *(Refer to page 14)*
- **Do not install a power factor correction capacitor, surge suppressor or noise filter (capacitor) on the drive unit output side. This will cause the drive unit to trip or the capacitor and surge suppressor to be damaged. If any of the above devices are connected, immediately remove them.**
- **Electromagnetic wave interference**
  The input/output (main circuit) of the drive unit includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the drive unit. In this case, install the FR-BIF optional noise filter (capacitor) (for use in the input side only) or FR-BSF01 or FR-BLF noise filter (ferrite core) to minimize interference. *(Refer to page 36)*
- **Refer to the instruction manual of each option and peripheral devices for details of peripheral devices.**
- **A PM motor cannot be driven by the commercial power supply.**
- **A PM motor is a magnet motor. High-voltage is generated at motor terminals while the motor is running even after the drive unit power is turned OFF. Before closing the magnetic motor starter at the output side, make sure that the drive unit power is ON and the motor is stopped.**
- **Do not use a magnetic contactor at the drive unit's output side.**

1.2.1 Peripheral devices

Check the drive unit model of the drive unit you purchased. Appropriate peripheral devices must be selected according to the capacity.
Refer to the following list and prepare appropriate peripheral devices.

(1) MM-GKR motor

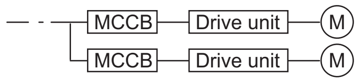
Applicable drive unit Model	Motor Output (kW)	Moulded Case Circuit Breaker (MCCB) *1 or Earth Leakage Circuit Breaker (ELB) *2 (NF, NV type)		Magnetic Contactor (MC) *3		Reactor	
		Reactor connection		Reactor connection		FR-HAL	FR-HEL
		without	with	without	with		
FR-E720EX-0.1K	0.1	5A	5A	S-T10	S-T10	0.4K *4	0.4K *4
FR-E720EX-0.2K	0.2	5A	5A	S-T10	S-T10	0.4K *4	0.4K *4
FR-E720EX-0.4K	0.4	5A	5A	S-T10	S-T10	0.4K	0.4K
FR-E720EX-0.75K	0.75	10A	10A	S-T10	S-T10	0.75K	0.75K



*1 •Select an MCCB according to the power supply capacity.
•Install one MCCB per drive unit.
*2 For the use in the United States or Canada, select a UL and cUL certified fuse with Class T fuse equivalent cut-off speed or faster with the appropriate rating for branch circuit protection. Alternatively, select a UL489 molded case circuit breaker (MCCB). (*Refer to the Instruction Manual (Basic)*)
*3 Magnetic contactor is selected based on the AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the magnetic contactor is used for emergency stop during motor driving, the electrical durability is 25 times.
If using an MC for emergency stop during motor driving, select an MC regarding the drive unit input side current as JEM1038-AC-3 class rated current.
*4 The power factor may be slightly lower.

(2) S-PM geared motor Ver.UP

Applicable drive unit Model	Motor Output (kW)	Moulded Case Circuit Breaker (MCCB) *1 or Earth Leakage Circuit Breaker (ELB) *2 (NF, NV type)		Magnetic Contactor (MC) *3		Reactor	
		Reactor connection		Reactor connection		FR-HAL	FR-HEL
		without	with	without	with		
FR-E720EX-0.2K	0.1	5A	5A	S-T10	S-T10	0.4K*4	0.4K*4
FR-E720EX-0.4K	0.2	5A	5A	S-T10	S-T10	0.4K*4	0.4K*4
FR-E720EX-0.75K	0.4	10A	5A	S-T10	S-T10	0.4K	0.4K
FR-E720EX-1.5K	0.75	15A	10A	S-T10	S-T10	0.75K	0.75K
FR-E720EX-2.2K	1.5	20A	15A	S-T10	S-T10	1.5K	1.5K
FR-E720EX-3.7K	2.2	30A	30A	S-T21	S-T10	2.2K	2.2K



*1 •Select an MCCB according to the power supply capacity.
•Install one MCCB per drive unit.
*2 For the use in the United States or Canada, select a UL and cUL certified fuse with Class T fuse equivalent cut-off speed or faster with the appropriate rating for branch circuit protection. Alternatively, select a UL489 molded case circuit breaker (MCCB). (*Refer to the Instruction Manual (Basic)*)
*3 Magnetic contactor is selected based on the AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the magnetic contactor is used for emergency stop during motor driving, the electrical durability is 25 times.
If using an MC for emergency stop during motor driving, select an MC regarding the drive unit input side current as JEM1038-AC-3 class rated current.
*4 The power factor may be slightly lower.

Ver.UP ....Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

NOTE

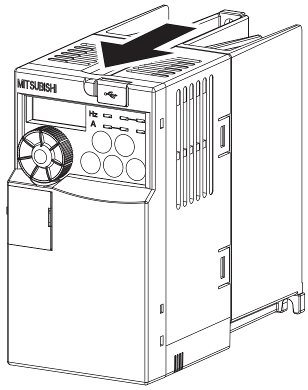
- **When using the S-PM geared motor, select an MCCB and a magnetic contactor according to the drive unit model, and select cables and reactors according to the motor output.**
- **When the breaker on the drive unit input side trips, check for the wiring fault (short circuit), damage to internal parts of the drive unit, etc. Identify the cause of the trip, then remove the cause and power ON the breaker.**

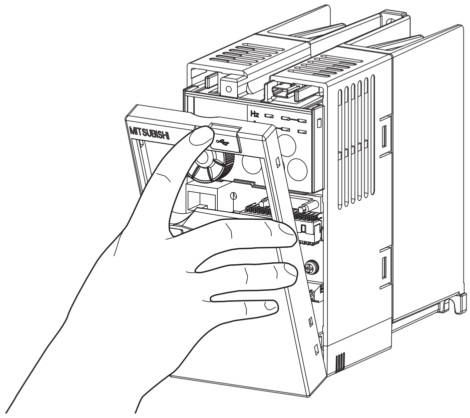
1.3 Removal and reinstallation of the cover

1.3.1 Front cover

●Removal (Example of FR-E720EX-0.75K)

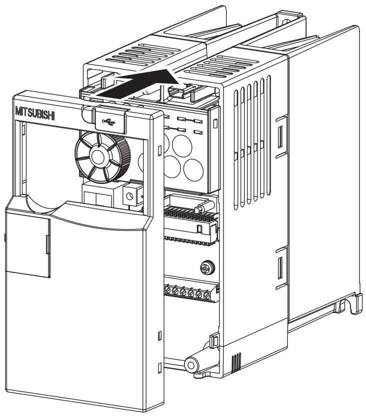
Remove the front cover by pulling in the direction of arrow.

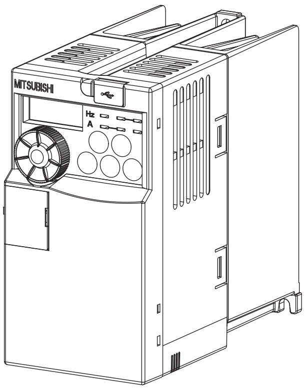




●Reinstallation (Example of FR-E720EX-0.75K)

To reinstall, match the cover to the drive unit front and install it straight.





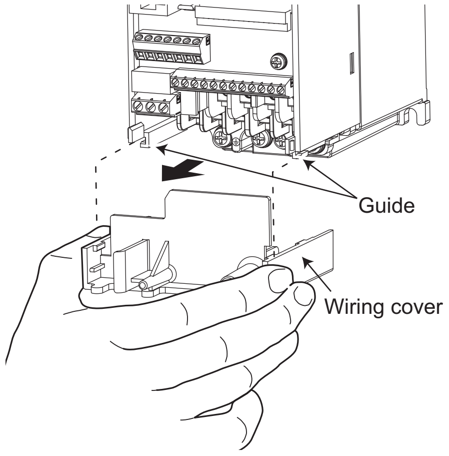
NOTE

- **Fully make sure that the front cover has been reinstalled securely.**
- **The same serial number is printed on the capacity plate of the front cover and the rating plate of the drive unit. Since these plates have the same serial numbers, always reinstall the removed cover onto the original drive unit.**

1.3.2 Wiring cover

●Removal and reinstallation

The cover can be removed easily by pulling. To reinstall, fit the cover to the drive unit along the guides.



Example of FR-E720EX-0.75K

1.4 Installation of the drive unit and enclosure design

When a drive unit enclosure is to be designed and manufactured, heat generated by contained equipment, etc., the environment of an operating place, and others must be fully considered to determine the enclosure structure, size and equipment layout. The drive unit uses many semiconductor devices. To ensure higher reliability and long period of operation, operate the drive unit in the ambient environment that completely satisfies the equipment specifications.

1.4.1 Drive unit installation environment

As the drive unit installation environment should satisfy the standard specifications indicated in the following table, operation in any place that does not meet these conditions not only deteriorates the performance and life of the drive unit, but also causes a failure. Refer to the following points and take adequate measures.

Environmental standard specifications of drive unit

Item	Description
Surrounding air temperature	-10 to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Atmosphere	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
Maximum altitude	1,000m or less
Vibration	5.9m/s^2 or less at 10 to 55Hz (directions of X, Y, Z axes)

(1) Temperature

The permissible surrounding air temperature of the drive unit is between -10 and +50°C. Always operate the drive unit within this temperature range. Operation outside this range will considerably shorten the service lives of the semiconductors, parts, capacitors and others. Take the following measures so that the surrounding air temperature of the drive unit falls within the specified range.

1) Measures against high temperature
   - Use a forced ventilation system or similar cooling system. *(Refer to page 9)*
   - Install the panel in an air-conditioned electrical chamber.
   - Block direct sunlight.
   - Provide a shield or similar plate to avoid direct exposure to the radiated heat and wind of a heat source.
   - Ventilate the area around the panel well.

2) Measures against low temperature
   - Provide a space heater in the enclosure.
   - Do not power OFF the drive unit. (Keep the start signal of the drive unit OFF.)

3) Sudden temperature changes
   - Select an installation place where temperature does not change suddenly.
   - Avoid installing the drive unit near the air outlet of an air conditioner.
   - If temperature changes are caused by opening/closing of a door, install the drive unit away from the door.

(2) Humidity

Normally operate the drive unit within the 45 to 90% range of the ambient humidity. Too high humidity will pose problems of reduced insulation and metal corrosion. On the other hand, too low humidity may produce a spatial electrical breakdown. The insulation distance specified in JEM1103 "Control Equipment Insulator" is defined as humidity 45 to 85%.

1) Measures against high humidity
   - Make the panel enclosed, and provide it with a hygroscopic agent.
   - Take dry air into the enclosure from outside.
   - Provide a space heater in the enclosure.

2) Measures against low humidity
   What is important in fitting or inspection of the unit in this status is to discharge your body (static electricity) beforehand and keep your body from contact with the parts and patterns, besides blowing air of proper humidity into the panel from outside.

3) Measures against condensation
   Condensation may occur if frequent operation stops change the in-panel temperature suddenly or if the outside-air temperature changes suddenly.
   Condensation causes such faults as reduced insulation and corrosion.
   - Take the measures against high humidity in 1).
   - Do not power OFF the drive unit. (Keep the start signal of the drive unit OFF.)

(3) Dust, dirt, oil mist

Dust and dirt will cause such faults as poor contact of contact points, reduced insulation or reduced cooling effect due to moisture absorption of accumulated dust and dirt, and in-panel temperature rise due to clogged filter. In the atmosphere where conductive powder floats, dust and dirt will cause such faults as malfunction, deteriorated insulation and short circuit in a short time.
Since oil mist will cause similar conditions, it is necessary to take adequate measures.

Countermeasures

- Place in a totally enclosed enclosure.
  Take measures if the in-enclosure temperature rises. *(Refer to page 9)*
- Purge air.
  Pump clean air from outside to make the in-panel pressure higher than the outside-air pressure.

(4) Corrosive gas, salt damage

If the drive unit is exposed to corrosive gas or to salt near a beach, the printed board patterns and parts will corrode or the relays and switches will result in poor contact.
In such places, take the measures given in Section 3.

(5) Explosive, flammable gases

As the drive unit is non-explosion proof, it must be contained in an explosion proof enclosure. In places where explosion may be caused by explosive gas, dust or dirt, an enclosure cannot be used unless it structurally complies with the guidelines and has passed the specified tests. This makes the enclosure itself expensive (including the test charges). The best way is to avoid installation in such places and install the drive unit in a non-hazardous place.

(6) Highland

Use the drive unit at the altitude of within 1000m. If it is used at a higher place, it is likely that thin air will reduce the cooling effect and low air pressure will deteriorate dielectric strength.

(7) Vibration, impact

The vibration resistance of the drive unit is up to 5.9m/s^2 at 10 to 55Hz frequency and 1mm amplitude for the directions of X, Y, Z axes. Vibration or impact, if less than the specified value, applied for a long time may make the mechanism loose or cause poor contact to the connectors.
Especially when impact is imposed repeatedly, caution must be taken as the part pins are likely to break.

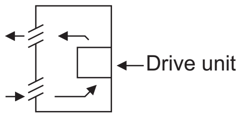
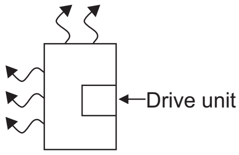
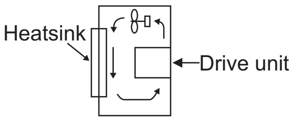
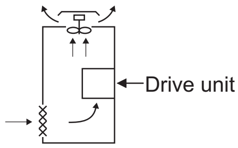
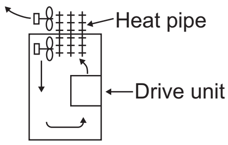
Countermeasures

- Provide the panel with rubber vibration isolators.
- Strengthen the structure to prevent the panel from resonance.
- Install the panel away from sources of vibration.

1.4.2 Cooling system types for drive unit panel

From the panel that contains the drive unit, the heat of the drive unit and other equipment (transformers, lamps, resistors, etc.) and the incoming heat such as direct sunlight must be dissipated to keep the in-panel temperature lower than the permissible temperatures of the in-panel equipment including the drive unit.
The cooling systems are classified as follows in terms of the cooling calculation method.

1) Cooling by natural heat dissipation from the enclosure surface (totally enclosed type)
2) Cooling by heat sink (aluminum fin, etc.)
3) Cooling by ventilation (forced ventilation type, pipe ventilation type)
4) Cooling by heat exchanger or cooler (heat pipe, cooler, etc.)

Cooling System		Panel Structure	Comment
Natural cooling	Natural ventilation (enclosed, open type)		Low in cost and generally used, but the panel size increases as the drive unit capacity increases. For relatively small capacities.
	Natural ventilation (totally enclosed type)		Being a totally enclosed type, the most appropriate for hostile environment having dust, dirt, oil mist, etc. The panel size increases depending on the drive unit capacity.
Forced cooling	Fin cooling		Having restrictions on the heatsink mounting position and area, and designed for relative small capacities.
	Forced ventilation		For general indoor installation. Appropriate for panel downsizing and cost reduction, and often used.
	Heat pipe		Totally enclosed type for panel downsizing.

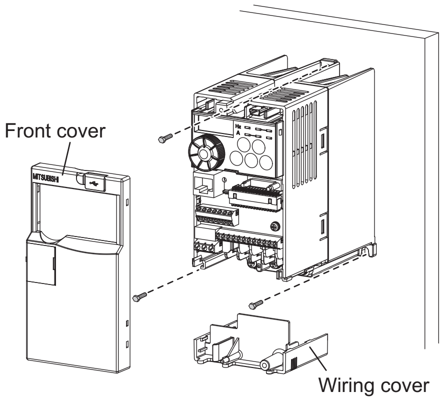
1.4.3 Drive unit placement

(1) Installation of the drive unit

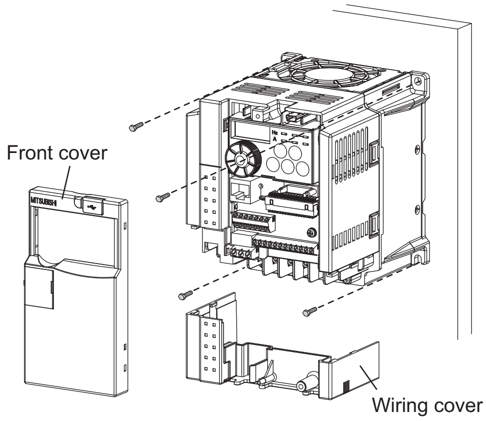
Enclosure surface mounting

Remove the front cover and wiring cover to fix the drive unit to the surface.

●FR-E720EX-0.1K to 0.75K

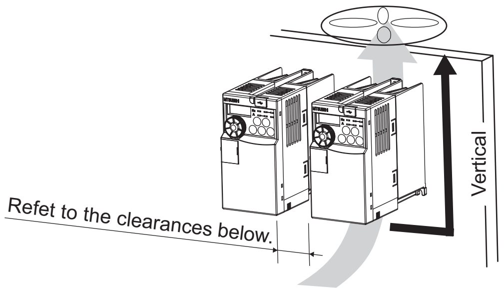


●FR-E720EX-1.5K to 3.7K



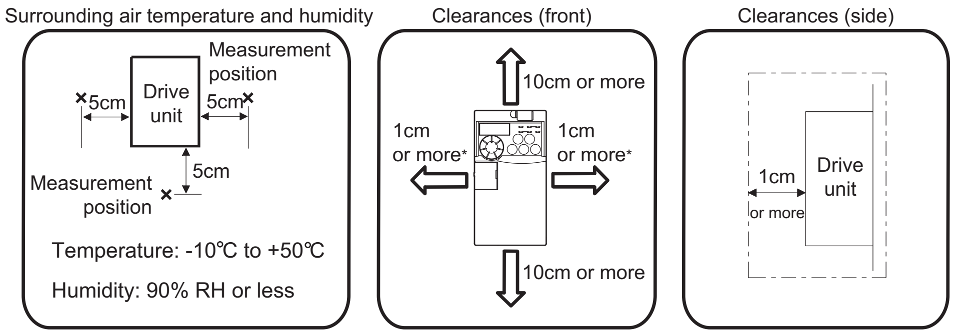
NOTE

- **When encasing multiple drive units, install them in parallel as a cooling measure.**
- **Install the drive unit vertically.**



(2) Clearances around drive unit

To ensure ease of heat dissipation and maintenance, leave at least the shown clearances around the drive unit. At least the following clearances are required under the drive unit as a wiring space, and above the drive unit as a heat dissipation space.



Leave enough clearances and take cooling measures.

* When using the drive units at the surrounding air temperature of 40℃ or less, the drive units can be installed without any clearance between them (0cm clearance).
When surrounding air temperature exceeds 40℃, clearances between the drive units should be 1cm or more.

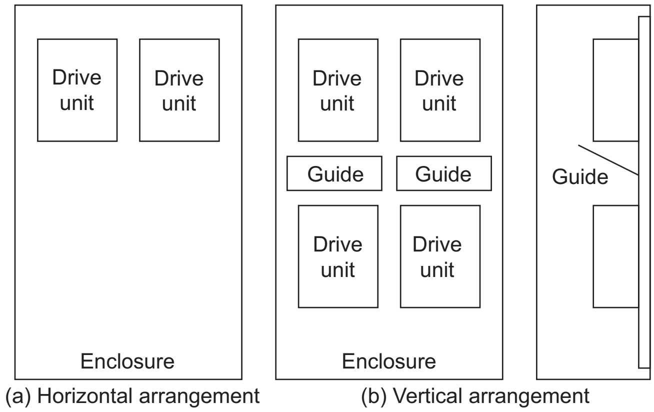
(3) Drive unit mounting orientation

Mount the drive unit on a wall as specified. Do not mount it horizontally or any other way.

(4) Arrangement of multiple drive units

When multiple drive units are placed in the same enclosure, generally arrange them horizontally as shown in the right figure (a). When it is inevitable to arrange them vertically to minimize space, take such measures as to provide guides since heat from the bottom drive units can increase the temperatures in the top drive units, causing drive unit failures.

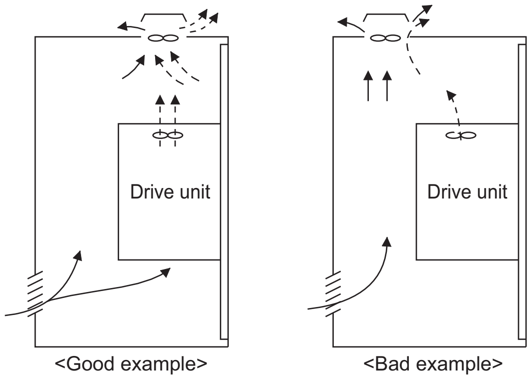
When mounting multiple drive units, fully take caution not to make the surrounding air temperature of the drive unit higher than the permissible value by providing ventilation and increasing the panel size.



Arrangement of multiple drive units

(5) Arrangement of ventilation fan and drive unit

Heat generated in the drive unit is blown up from the bottom of the unit as warm air by the cooling fan. When installing a ventilation fan for that heat, determine the place of ventilation fan installation after fully considering an air flow. (Air passes through areas of low resistance. Make an airway and airflow plates to expose the drive unit to cool air.)



Placement of ventilation fan and drive unit

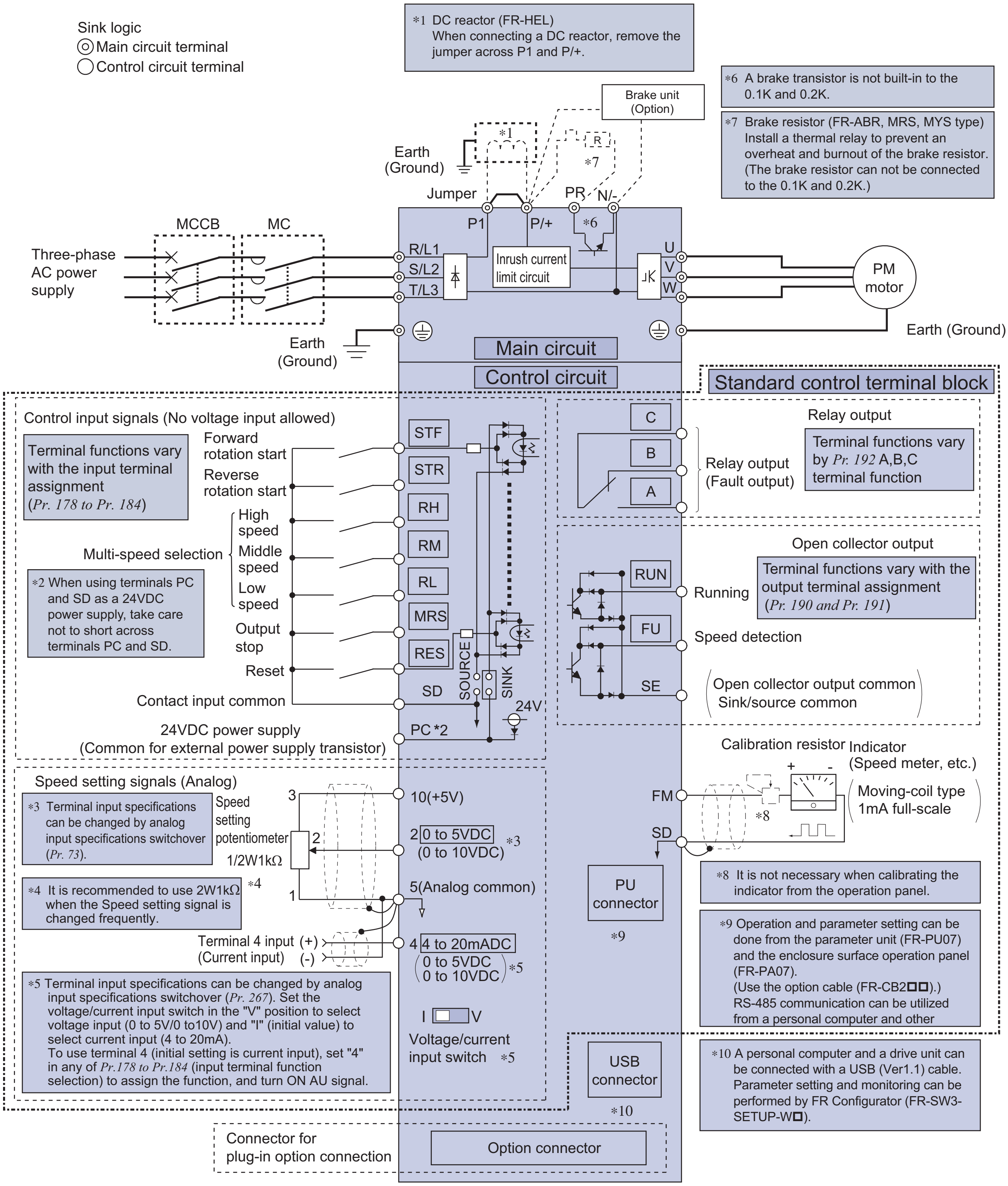
MEMO

2 WIRING

This chapter describes the basic "WIRING" for use of this product.
Always read the instructions before using the equipment.

2.1 Wiring

Terminal connection diagram (Speed control)



NOTE

- **For the terminal connection diagram for the position control,** *refer to page 90*.
- **To prevent a malfunction caused by noise, separate the signal cables more than 10cm from the power cables. Also separate the main circuit wire of the input side and the output side.**
- **After wiring, wire offcuts must not be left in the drive unit.**
  Wire offcuts can cause an alarm, failure or malfunction. Always keep the drive unit clean. When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the drive unit.

2.2 Main circuit terminal specifications

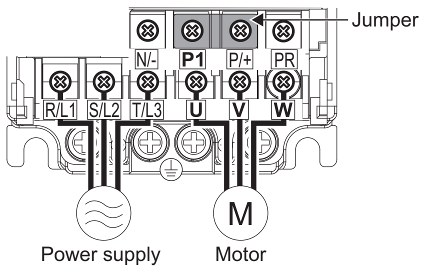
2.2.1 Specification of main circuit terminal

Terminal Symbol	Terminal Name	Description
R/L1, S/L2, T/L3	AC power input	Connect to the commercial power supply. Keep these terminals open when using the high power factor converter (FR-HC2) or power regeneration common converter (FR-CV).
U, V, W	Drive unit output	Connect a three-phase squirrel-cage motor.
P/+, PR	Brake resistor connection	Connect a brake resistor (FR-ABR, MRS type, MYS type) across terminals P/+ and PR. (The brake resistor can not be connected to the 0.1K or 0.2K.)
P/+, N/-	Brake unit connection	Connect the brake unit (FR-BU2), power regeneration common converter (FR-CV) or high power factor converter (FR-HC2).
P/+, P1	DC reactor connection	Remove the jumper across terminals P/+ and P1 and connect a DC reactor.
⏚	Earth (Ground)	For earthing (grounding) the drive unit chassis. Must be earthed (grounded).

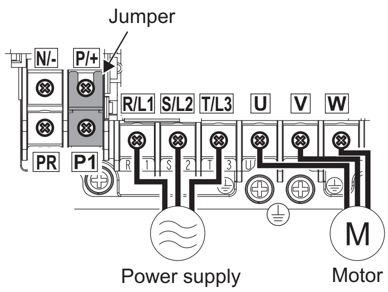
2.2.2 Terminal arrangement of the main circuit terminal, power supply and the motor wiring

Three-phase 200V class

FR-E720EX-0.1K to 0.75K



FR-E720EX-1.5K to 3.7K



NOTE

- **Make sure the power cables are connected to the R/L1, S/L2, T/L3. (Phase need not be matched.) Never connect the power cable to the U, V, W of the drive unit. Doing so will damage the drive unit.**
- **Connect the motor to U, V, W. Turning ON the forward rotation switch (signal) at this time rotates the motor counterclockwise when viewed from the load shaft.**

2.2.3 Cables and wiring length

(1) Applicable cable size

Select the recommended cable size to ensure that a voltage drop will be 2% at maximum.
The following table indicates a selection example for the wiring length of 20m.

Three-phase 200V class (when input power supply is 220V)

(1) MM-GKR motor

Applicable drive unit Model	Terminal Screw Size *4	Tightening Torque N·m	Crimping Terminal		Cable Size							
					HIV Cables, etc. (mm^2) *1			AWG *2		PVC Cables, etc. (mm^2) *3		
			R/L1 S/L2 T/L3	U, V, W	R/L1 S/L2 T/L3	U, V, W	Earthing (grounding) cable	R/L1 S/L2 T/L3	U, V, W	R/L1 S/L2 T/L3	U, V, W	Earthing (grounding) cable
FR-E720EX-0.1K to 0.75K	M3.5	1.2	2-3.5	1.25-3.5	2	- (*5)	2	14	- (*5)	2.5	- (*5)	2.5

*1 The cable size is that of the cable (HIV cable (600V class 2 vinyl-insulated cable) etc.) with continuous maximum permissible temperature of 75°C. Assumes that the surrounding air temperature is 50°C or less and the wiring distance is 20m or less.
*2 The recommended cable size is that of the cable (THHW cable) with continuous maximum permissible temperature of 75°C. Assumes that the surrounding air temperature is 40°C or less and the wiring distance is 20m or less. (Selection example for use mainly in the United States.)
*3 The recommended cable size is that of the cable (PVC cable) with continuous maximum permissible temperature of 70°C. Assumes that the surrounding air temperature is 40°C or less and the wiring distance is 20m or less. (Selection example for use mainly in Europe.)
*4 The terminal screw size indicates the terminal size for R/L1, S/L2, T/L3, U, V, W, PR, P/+, N/-, P1 and a screw for earthing (grounding).
*5 The size is 0.75mm^2 (AWG19 or AWG18) when using the motor power supply cable for MM-GKR motor (MR-PWS1CBL□M-A□-□).
When the wiring length of the power supply cable for the motor is 10 m or longer, extend the cable using MR-PWS2CBL03M-A_-L and an HIV wire of 1.25 mm^2 (AWG 16)
For compliance with UL/CSA standards, extend the power supply cable for the motor using MR-PWS2CBL03M-A_-L and an HIV wire of 2 mm^2 (AWG 14).

(2) S-PM geared motor Ver.UP

Applicable drive unit Model	Terminal Screw Size *4	Tightening Torque N·m	Crimping Terminal		Cable Size							
					HIV Cables, etc. (mm^2) *1			AWG *2		PVC Cables, etc. (mm^2) *3		
			R/L1 S/L2 T/L3	U, V, W	R/L1 S/L2 T/L3	U, V, W	Earthing (grounding) cable	R/L1 S/L2 T/L3	U, V, W	R/L1 S/L2 T/L3	U, V, W	Earthing (grounding) cable
FR-E720EX-0.2K to 0.75K	M3.5	1.2	2-3.5	2-3.5	2	2	2	14	14	2.5	2.5	2.5
FR-E720EX-1.5K to 3.7K	M4	1.5	2-4	2-4								

*1 The cable size is that of the cable (HIV cable (600V class 2 vinyl-insulated cable) etc.) with continuous maximum permissible temperature of 75°C. Assumes that the surrounding air temperature is 50°C or less and the wiring distance is 20m or less.
*2 The recommended cable size is that of the cable (THHW cable) with continuous maximum permissible temperature of 75°C. Assumes that the surrounding air temperature is 40°C or less and the wiring distance is 20m or less. (Selection example for use mainly in the United States.)
*3 The recommended cable size is that of the cable (PVC cable) with continuous maximum permissible temperature of 70°C. Assumes that the surrounding air temperature is 40°C or less and the wiring distance is 20m or less. (Selection example for use mainly in Europe.)
*4 The terminal screw size indicates the terminal size for R/L1, S/L2, T/L3, U, V, W, PR, P/+, N/-, P1 and a screw for earthing (grounding).

Ver.UP .... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

NOTE

- **Tighten the terminal screw to the specified torque. A screw that has been tighten too loosely can cause a short circuit or malfunction. A screw that has been tighten too tightly can cause a short circuit or malfunction due to the unit breakage.**
- **Use crimping terminals with insulation sleeve to wire the power supply and motor.**

The line voltage drop can be calculated by the following formula:

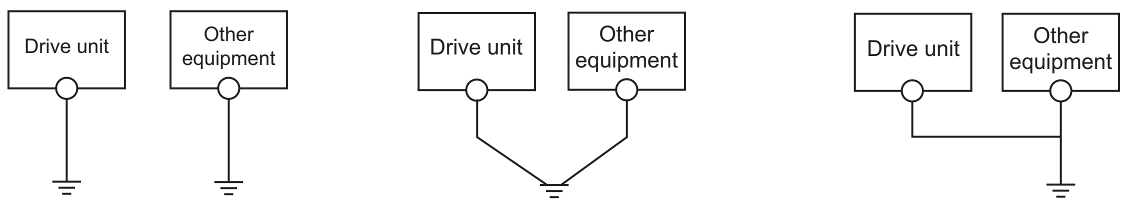
$$\text{Line voltage drop [V]} = \frac{\sqrt{3} \times \text{wire resistance[m}\Omega\text{/m]} \times \text{wiring distance[m]} \times \text{current[A]}}{1000}$$

Use a larger diameter cable when the wiring distance is long or when it is desired to decrease the voltage drop (torque reduction) in the low speed range.

(2) Earthing (Grounding) precautions

- Always earth (ground) the motor and drive unit.
  1) Purpose of earthing (grounding)
     Generally, an electrical apparatus has an earth (ground) terminal, which must be connected to the ground before use.
     An electrical circuit is usually insulated by an insulating material and encased. However, it is impossible to manufacture an insulating material that can shut off a leakage current completely, and actually, a slight current flow into the case. The purpose of earthing (grounding) the case of an electrical apparatus is to prevent operator from getting an electric shock from this leakage current when touching it.
     To avoid the influence of external noises, this earthing (grounding) is important to audio equipment, sensors, computers and other apparatuses that handle low-level signals or operate very fast.

  2) Earthing (grounding) methods and earthing (grounding) work
     As described previously, earthing (grounding) is roughly classified into an electrical shock prevention type and a noise-affected malfunction prevention type. Therefore, these two types should be discriminated clearly, and the following work must be done to prevent the leakage current having the drive unit's high frequency components from entering the malfunction prevention type earthing (grounding):
     (a) If possible, use (I) independent earthing (grounding) in figure below for the drive unit. If independent earthing (grounding) is not available, use (II) joint earthing (grounding) in the figure below where the drive unit is connected with the other equipment at an earthing (grounding) point. The (III) common earthing (grounding) as in the figure below, which drive unit shares a common earthing cable with the other equipment, must be avoided.
     A leakage current including many high frequency components flows in the earthing (grounding) cables of the drive unit and drive unit-driven motor. Therefore, use the independent earthing (grounding) and separate the earthing (grounding) cable of the drive unit from equipment sensitive to EMI.
     In a high building, it may be effective to use the EMI prevention type earthing (grounding) connecting to an iron structure frame, and electric shock prevention type earthing (grounding) with the independent earthing (grounding) together.
     (b) This drive unit must be earthed (grounded). Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 536 class 1 and other applicable standards).
     (c) Use the thickest possible earthing (grounding) cable. The earthing (grounding) cable size should be no less than the size indicated in the table on the previous *page 16*.
     (d) The grounding point should be as close as possible to the drive unit, and the ground wire length should be as short as possible.
     (e) Run the earthing cable as far away as possible from the I/O wiring of equipment sensitive to noises and run them in parallel in the minimum distance.



(I)Independent earthing (grounding).......Best (II)Common earthing (grounding).......Good (III)Common earthing (grounding) cable.......Not allowed

POINT

To be compliant with the EU Directive (Low Voltage Directive), *refer to the Instruction Manual (Basic)*.

(3) Wiring length

Connect a PM motor within the total wiring length of 30m.
Use one dedicated PM motor for one drive unit. Multiple PM motors cannot be connected to a drive unit.

2

WIRING

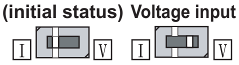
2.3 Control circuit specifications

2.3.1 Control circuit terminal

[ ] indicates that terminal functions can be selected using *Pr.178 to Pr.184, Pr.190 to Pr.192 (I/O terminal function selection)*. *(Refer to page 138)*

(1) Input signal (Speed control)

Type	Terminal Symbol	Terminal Name	Description	Rated Specifications	Refer to Page
Contact input	STF	Forward rotation start	Turn ON the STF signal to start forward rotation and turn it OFF to stop. When the STF and STR signals are turned ON simultaneously, the stop command is given.	Input resistance 4.7kΩ Voltage at opening 21 to 26VDC Current at short-circuited 4 to 6mADC	*142*
	STR	Reverse rotation start	Turn ON the STR signal to start reverse rotation and turn it OFF to stop. When the STF and STR signals are turned ON simultaneously, the stop command is given.		*142*
	RH, RM, RL	Multi-speed selection	Multi-speed can be selected according to the combination of RH, RM and RL signals.		*117*
	MRS	Output stop	Turn ON the MRS signal (20ms or more) to stop the drive unit output. Use to shut off the drive unit output when stopping the motor by electromagnetic brake.		*140*
	RES	Reset	Use to reset fault output provided when fault occurs. Turn ON the RES signal for more than 0.1s, then turn it OFF. In the initial status, reset is set always-enabled. By setting *Pr.75*, reset can be set enabled only at fault occurrence. Recover about 1s after reset is cancelled.		*178*
	SD	Contact input common (sink) (initial setting)	Common terminal for contact input terminal (sink logic) and terminal FM.	—	—
		External transistor common (source)	When connecting the transistor output (open collector output), such as a programmable controller, when source logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.		
		24VDC power supply common	Common output terminal for 24VDC 0.1A power supply (PC terminal). Isolated from terminals 5 and SE.		
	PC	External transistor common (sink) (initial setting)	When connecting the transistor output (open collector output), such as a programmable controller, when sink logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.	Power supply voltage range 22 to 26.5VDC permissible load current 100mA	*21*
		Contact input common (source)	Common terminal for contact input terminal (source logic).		
		24VDC power supply	Can be used as 24VDC 0.1A power supply.		

Type	Terminal Symbol	Terminal Name	Description	Rated Specifications	Refer to Page
Speed setting	10	Speed setting power supply	Used as power supply when connecting potentiometer for speed setting (speed setting) from outside of the drive unit. *(Refer to Pr.73 Analog input selection)*	5.2V ± 0.2VDC permissible load current 10mA	*168*
	2	Speed setting (voltage)	Inputting 0 to 5VDC (or 0 to 10V) provides the maximum rotation speed at 5V (10V) and makes input and output proportional. Use *Pr.73* to switch between input 0 to 5VDC input (initial setting) and 0 to 10VDC.	Input resistance 10kΩ ± 1kΩ Permissible maximum voltage 20VDC	*168*
	4	Speed setting (current)	Inputting 4 to 20mADC (or 0 to 5V, 0 to 10V) provides the maximum rotation speed at 20mA and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input is invalid). To use terminal 4 (initial setting is current input), set "4" to any of *Pr.178 to Pr.184 (input terminal function selection)*, and turn AU signal ON. Use *Pr.267* to switch input among 4 to 20mA (initial setting), 0 to 5VDC and 0 to 10VDC. Set the voltage/ current input switch in the "V" position to select voltage input (0 to 5V/0 to 10V). Current input (initial status) Voltage input 	Current input: Input resistance 233Ω ± 5Ω Maximum permissible current 30mA Voltage input: Input resistance 10kΩ ± 1kΩ Permissible maximum voltage 20VDC	*168*
	5	Speed setting common	Speed setting signal (terminal 2, 4) common terminal. Do not earth (ground).	—	—

NOTE

- **Under position control, some terminals have different functions.** *(Refer to page 90)*
- **Set *Pr.267* and a voltage/current input switch correctly, then input analog signals in accordance with the settings. Applying a voltage with voltage/current input switch in "I" position (current input is selected) or a current with switch in "V" position (voltage input is selected) could cause component damage of the drive unit or analog circuit of output devices.** *(Refer to page 168 for details)*

2

WIRING

(2) Output signal

<table>
<tr><th>Type</th><th>Terminal Symbol</th><th>Terminal Name</th><th colspan="2">Description</th><th>Rated Specifications</th><th>Reference Page</th></tr>
<tr><td>Relay</td><td>A, B, C</td><td>Relay output
(fault output)</td><td colspan="2">1 changeover contact output indicates that the drive unit protective function has activated and the output stopped.
Fault: discontinuity across B-C (continuity across AC),
Normal: continuity across B-C (discontinuity across A-C)</td><td>Contact capacity:230VAC 0.3A
(power factor =0.4)
30VDC 0.3A</td><td>144</td></tr>
<tr><td rowspan="3">Open collector</td><td>RUN</td><td>Drive unit running</td><td>Switched low when the drive unit rotation speed is equal to or higher than the starting rotation speed. Switched high during stop or DC injection brake operation. *</td><td rowspan="2">* Low indicates that the open collector output transistor is ON (conducts).
High indicates that the transistor is OFF (does not conduct).</td><td rowspan="2">Permissible load 24VDC (maximum 27VDC) 0.1A
(a voltage drop is 3.4V maximum when the signal is ON)</td><td>144</td></tr>
<tr><td>FU</td><td>Speed detection</td><td>Switched low when the drive unit rotation speed is equal to or higher than the preset detected rotation speed and high when less than the preset detected rotation speed. *</td><td>149</td></tr>
<tr><td>SE</td><td>Open collector output common</td><td colspan="2">Common terminal of terminal RUN and FU.</td><td>—</td><td>—</td></tr>
<tr><td>Pulse</td><td>FM</td><td>For meter</td><td colspan="2">Select one e.g. rotation speed from monitor items.
Not output during drive unit reset.
The output signal is proportional to the magnitude of the corresponding monitoring item.</td><td>Permissible load current 1mA
Output item: rotation speed (initial setting)
1440 pulses/s at 3000r/min</td><td>155</td></tr>
</table>

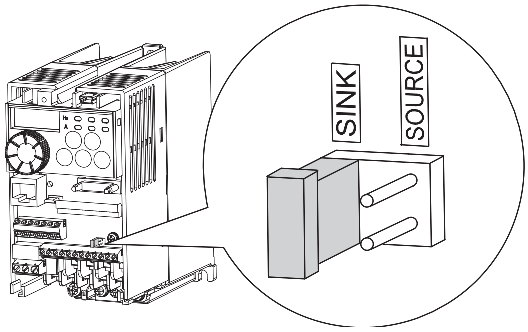
(3) Communication

Type	Terminal Symbol	Terminal Name	Description	Reference Page
RS-485	—	PU connector	With the PU connector, communication can be made through RS-485. •Conforming standard: EIA-485 (RS-485) •Transmission format: Multidrop link •Communication speed: 4800 to 38400bps •Overall length: 500m	201
USB	—	USB connector	The USB connection with a personal computer can be established. Using FR Configurator, setting, monitoring, and test operations of the drive unit can be performed. •Interface: conforms to USB1.1 •Transmission speed: 12Mbps •Connector: USB mini B connector (receptacle mini B type)	—

2.3.2 Changing the control logic

The input signals are set to sink logic (SINK) when shipped from the factory.
To change the control logic, the jumper connector above the control terminal must be moved to the other position.

- To change to source logic, change the jumper connector in the sink logic (SINK) position to source logic (SOURCE) position using tweezers, a pair of long-nose pliers etc. Change the jumper connector position before switching power ON.



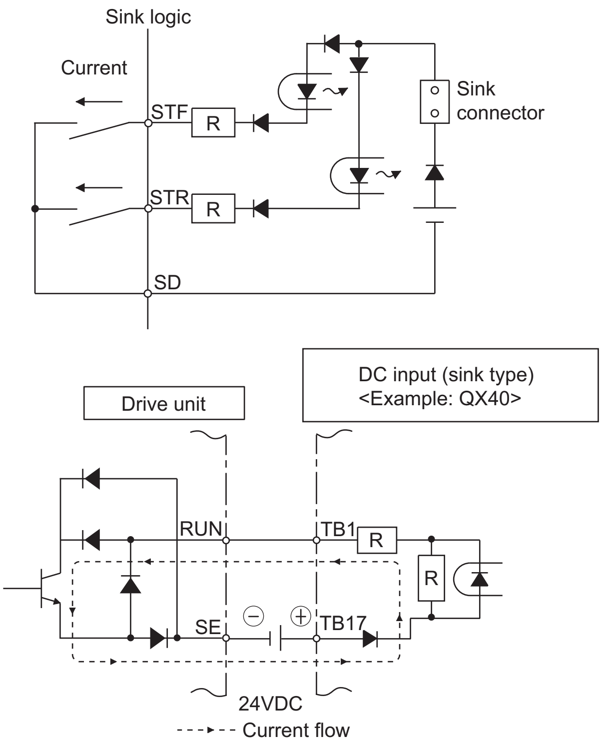
NOTE

- **Fully make sure that the front cover has been reinstalled securely.**
- **The capacity plate is placed on the front cover and the rating plate is on the drive unit. Since these plates have the same serial numbers, always reinstall the removed cover onto the original drive unit.**
- **The sink-source logic change-over jumper connector must be fitted in only one of those positions. If it is fitted in both positions at the same time, the drive unit may be damaged.**

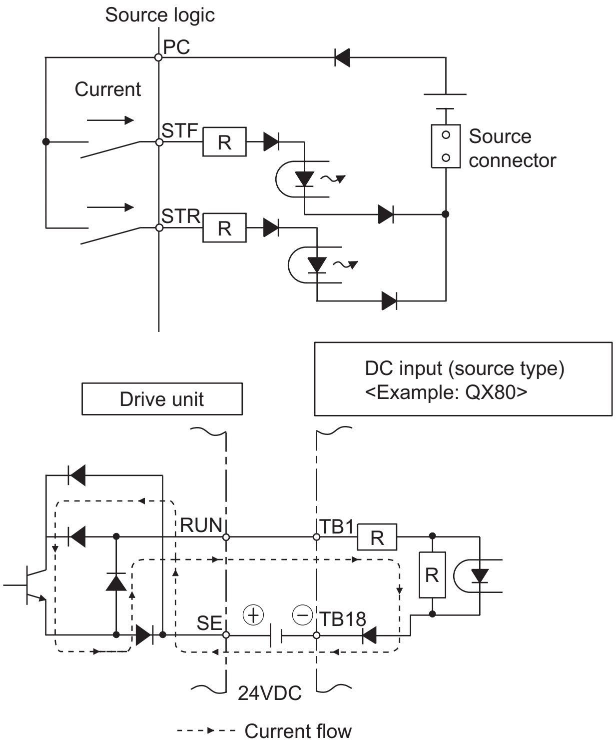
(1) Sink logic type and source logic type

- In sink logic, a signal switches ON when a current flows from the corresponding signal input terminal.
  Terminal SD is common to the contact input signals. Terminal SE is common to the open collector output signals.
- In source logic, a signal switches ON when a current flows into the corresponding signal input terminal.
  Terminal PC is common to the contact input signals. Terminal SE is common to the open collector output signals.

- Current flow concerning the input/output signal when sink logic is selected



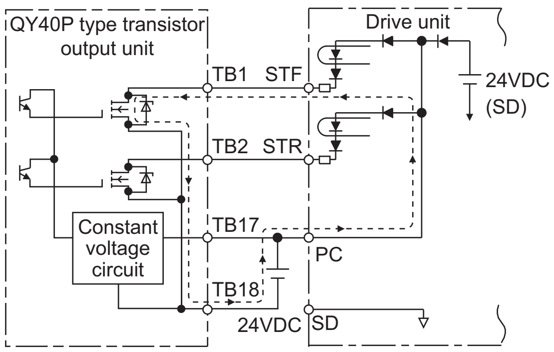
- Current flow concerning the input/output signal when source logic is selected



●When using an external power supply for transistor output

- Sink logic type

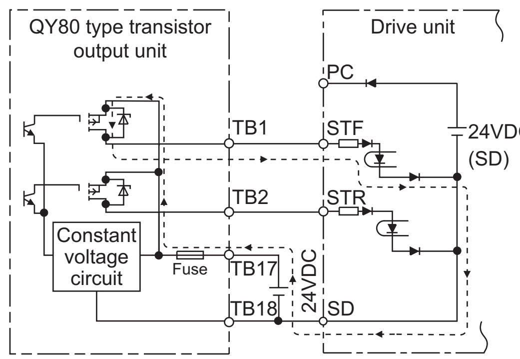
  Use terminal PC as a common terminal, and perform wiring as shown below. (Do not connect terminal SD of the drive unit with terminal 0V of the external power supply. When using terminals PC-SD as a 24VDC power supply, do not install an external power supply in parallel with the drive unit. Doing so may cause a malfunction in the drive unit due to undesirable currents.)



Current flow

- Source logic type

  Use terminal SD as a common terminal, and perform wiring as shown below. (Do not connect terminal PC of the drive unit with terminal +24V of the external power supply. When using terminals PC-SD as a 24VDC power supply, do not install an external power supply in parallel with the drive unit. Doing so may cause a malfunction in the drive unit due to undesirable currents.)

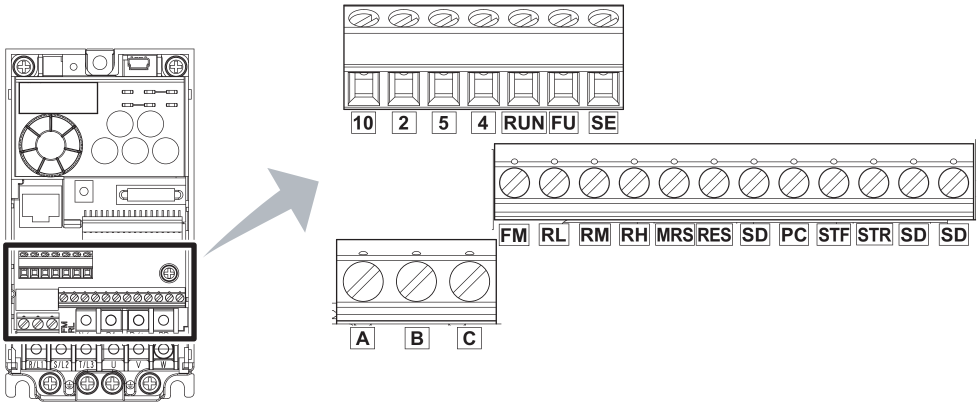


Current flow

2.3.3 Wiring of control circuit

● Terminal layout

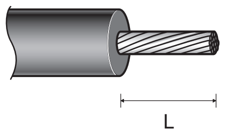
Terminal screw size
M3: (Terminal A, B, C)
M2: (Other than the above)

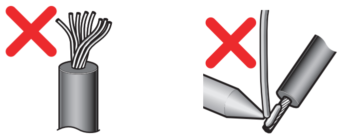


● Wiring method

1) Strip off the sheath of the wire of the control circuit to wire.
Strip off the sheath about the length below. If the length of the sheath peeled is too long, a short circuit may occur among neighboring wires. If the length is too short, wires might come off.
Wire the stripped wire after twisting it to prevent it from becoming loose. In addition, do not solder it. Use a blade terminal as necessary.

Wire stripping length





	L(mm)
Terminal A, B, C	6
Other than the above	5

Blade terminals available on the market: (as of Feb. 2012)

•Phoenix Contact Co.,Ltd.

Terminal Screw Size	Wire Size (mm^2)	Blade Terminal Model		Crimping Tool Name
		With Insulation Sleeve	Without Insulation Sleeve	
M3 (terminal A, B, C)	0.3, 0.5	AI 0,5-6WH	A 0,5-6	CRIMPFOX 6
	0.75	AI 0,75-6GY	A 0,75-6	
M2 (other than the above)	0.3, 0.5	AI 0,5-6WH	A 0,5-6	

•NICHIFU Co.,Ltd.

Terminal Screw Size	Wire Size (mm^2)	Blade terminal product number	Insulation product number	Crimping Tool Product Number
M3 (terminal A, B, C) M2 (other than the above)	0.3 to 0.75	BT 0.75-7	VC 0.75	NH 69

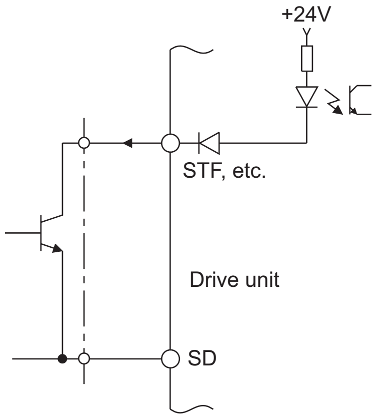
2) Loosen the terminal screw and insert the wire into the terminal.
3) Tighten the screw to the specified torque.
Undertightening can cause wire disconnection or malfunction. Overtightening can cause a short circuit or malfunction due to damage to the screw or unit.
Tightening torque: 0.5N·m to 0.6N·m (terminal A, B, C)
0.22N·m to 0.25N·m (other than the above)
Screwdriver: ⊖Small flathead screwdriver (Tip thickness: 0.4mm/tip width: 2.5mm)

(1) Control circuit common terminals (SD, 5, SE)

- Terminals SD, SE and 5 are common terminals for I/O signals. (All common terminals are isolated from each other.) Do not earth them. Avoid connecting the terminal SD and 5 and the terminal SE and 5.
- Terminal SD is a common terminal for the contact input terminals (STF, STR, RH, RM, RL, MRS, RES) and pulse train output signal (FM). The open collector circuit is isolated from the internal control circuit by photocoupler.
- Terminal 5 is a common terminal for the speed setting signals (terminal 2 or 4). It should be protected from external noise using a shielded or twisted wire.
- Terminal SE is a common terminal for the open collector output terminal (RUN, FU). The contact input circuit is isolated from the internal control circuit by photocoupler.

(2) Signal inputs by contactless switches

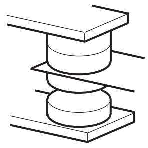
The contacted input terminals of the drive unit (STF, STR, RH, RM, RL, MRS, RES) can be controlled using a transistor instead of a contacted switch as shown on the right.



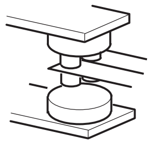
External signal input using transistor

(3) Wiring instructions

- It is recommended to use the wires of 0.3mm^2 to 0.75mm^2 gauge for connection to the control circuit terminals.
- The maximum wiring length should be 30m (200m for terminal FM).
- Do not short terminal PC and SD. Drive unit may be damaged.
- When using contact inputs, use two or more parallel micro-signal contacts or twin contacts to prevent contact faults since the control circuit input signals are micro-currents.



Micro signal contacts

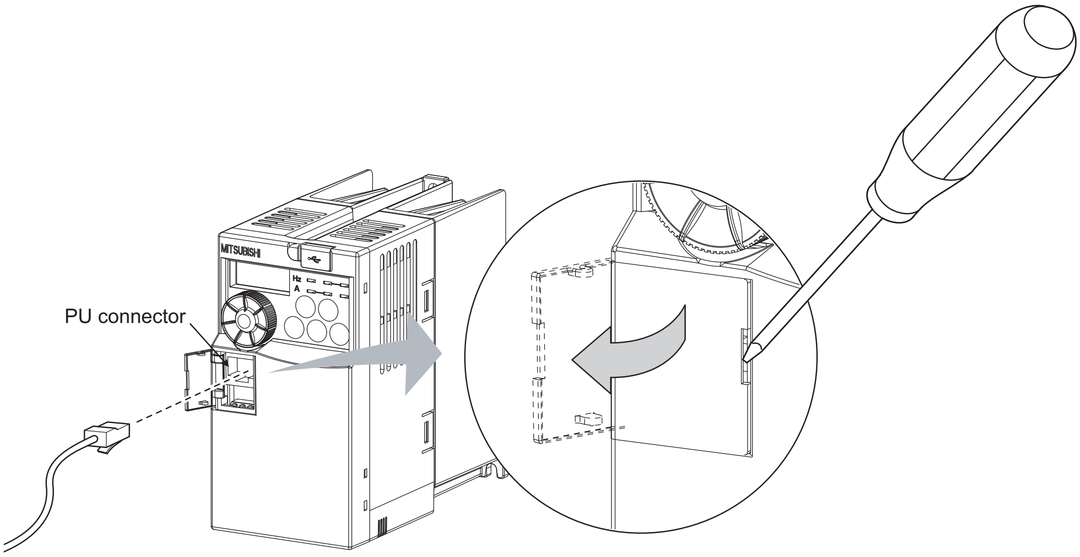


Twin contacts

- To suppress EMI, use shielded or twisted cables for the control circuit terminals and run them away from the main and power circuits (including the 200V relay sequence circuit). For the cables connected to the control circuit terminals, connect their shields to the common terminal of the connected control circuit terminal. When connecting an external power supply to the terminal PC, however, connect the shield of the power supply cable to the negative side of the external power supply. Do not directly earth (ground) the shield to the enclosure, etc.
- Do not apply a voltage to the contact input terminals (e.g. STF) of the control circuit.
- Always apply a voltage to the fault output terminals (A, B, C) via a relay coil, lamp, etc.

2.3.4 Connection to the PU connector

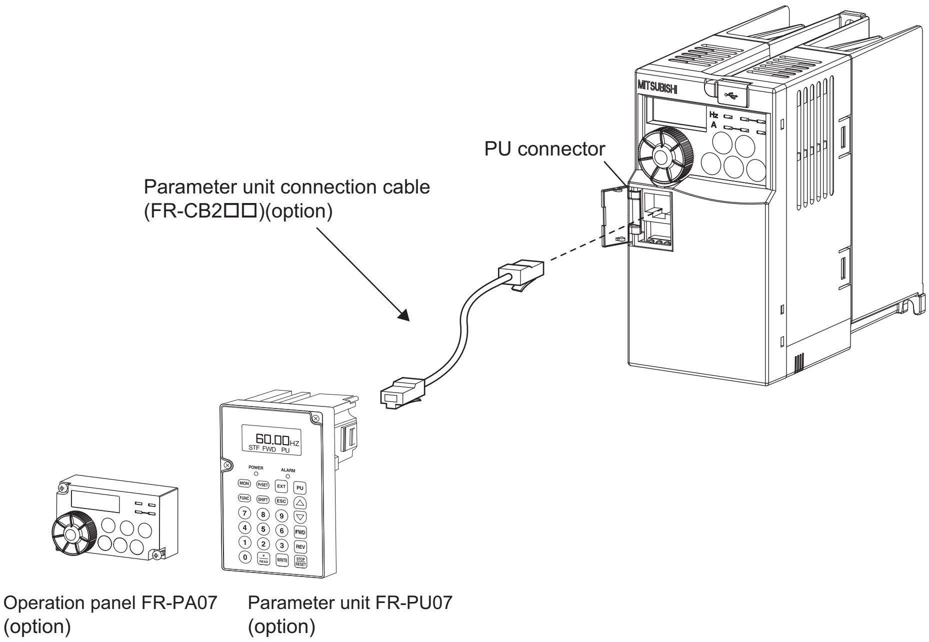
Using the PU connector, you can perform communication operation from the parameter unit (FR-PU07), enclosure surface operation panel (FR-PA07) or a personal computer etc.
Refer to the figure below to open the PU connector cover.



To open the cover
Place a flathead screwdriver, etc. in a slot and push up the cover to open.

●When connecting the parameter unit or enclosure surface operation panel using a connection cable

Use the optional FR-CB2□□ or connector and cable available on the market.
Insert the cable plugs securely into the PU connector of the drive unit and the connection connector of the FR-PU07 or FR-PA07 along the guide until the tabs snap into place.



REMARKS

- Refer to the following when fabricating the cable on hte user side. Keep the total cable length within 20m.
  Examples of product available on the market (as of February 2012)

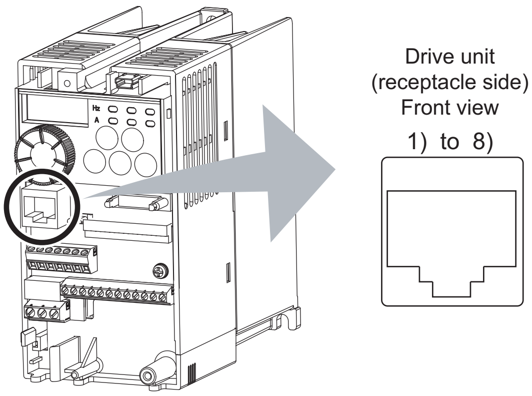
	Product	Type	Maker
1)	10BASE-T cable	SGLPEV-T (Cat5e/300m) 24AWG×4P	Mitsubishi Cable Industries, Ltd.
2)	RJ-45 connector	5-554720-3	Tyco Electronics Corporation

●RS-485 communication

When the PU connector is connected with a personal, FA or other computer by a communication cable, a user program can run and monitor the drive unit or read and write to parameters.

The protocol can be selected from Mitsubishi drive unit and Modbus-RTU.

•PU connector pin-outs



Pin Number	Name	Description
1)	SG	Earth (ground) (connected to terminal 5)
2)	—	Parameter unit power supply
3)	RDA	Drive unit receive+
4)	SDB	Drive unit send-
5)	SDA	Drive unit send+
6)	RDB	Drive unit receive-
7)	SG	Earth (ground) (connected to terminal 5)
8)	—	Parameter unit power supply

NOTE

- **Pins No. 2 and 8 provide power to the parameter unit. Do not use these pins for RS-485 communication.**
- **When making RS-485 communication with a combination of the FR-E700EX series, FR-E500 series, and FR-S500 series, incorrect connection of pins No.2 and 8 (parameter unit power supply) of the above PU connector may result in a malfunction or failure of the inverter or drive unit.**
- **Do not connect the PU connector to the computer's LAN board, FAX modem socket or telephone modular connector. The product could be damaged due to differences in electrical specifications.**

For further details, refer to *page 201*.

•Conforming standard: EIA-485 (RS-485)

•Transmission form: Multidrop link

•Communication speed: Maximum 38400 bps

•Overall extension: 500m

2.4 Connection of stand-alone option unit

The drive unit accepts a variety of stand-alone option units as required.
Incorrect connection will cause drive unit damage or accident. Connect and operate the option unit carefully in accordance with the corresponding option unit manual.

2.4.1 Connection of a dedicated external brake resistor (MRS type, MYS type, FR-ABR) (0.4K or higher)

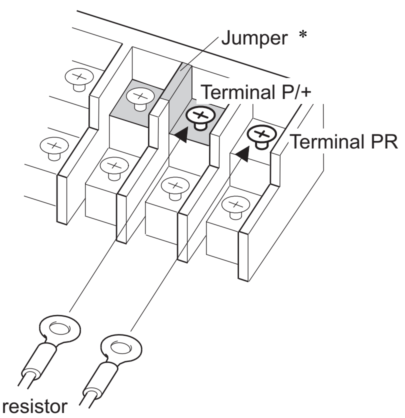
Install a dedicated brake resistor (MRS type, MYS type, FR-ABR) outside when the motor is made to run by the load, quick deceleration is required, etc. Connect a dedicated brake resistor to terminal P/+ and PR.
(For the locations of terminal P/+ and PR, refer to the terminal block layout *(page 15)*.)
Set parameters below.

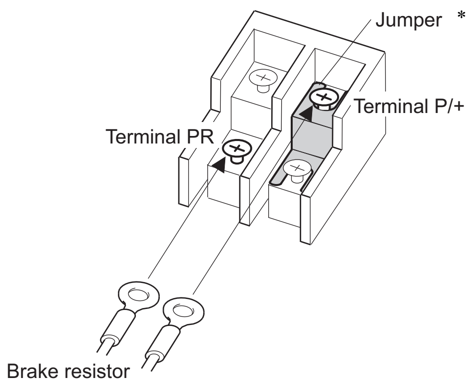
Connected brake resistor	*Pr.30 Regenerative function selection* Setting	*Pr.70 Special regenerative brake duty* Setting	
MRS type, MYS type	0 (initial value)	—	
MYS type (used at 100% torque / 6%ED)	1	6%	*Refer to page 136*
FR-ABR	1	10%	

NOTE

The brake resistor connected should only be the dedicated brake resistor.

FR-E720EX-0.4K, 0.75K	FR-E720EX-1.5K to 3.7K
Connect the brake resistor across terminals P/+ and PR.	Connect the brake resistor across terminals P/+ and PR.



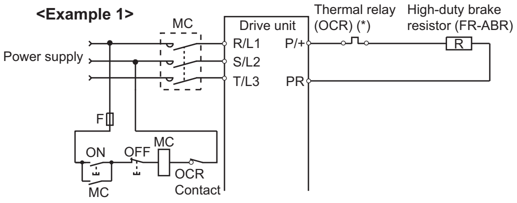


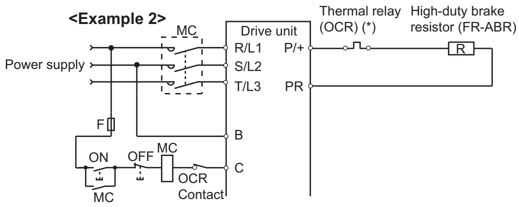
* Do not remove a jumper across terminal P/+ and P1 except when connecting a DC reactor.

2 WIRING

Connection of stand-alone option unit

It is recommended to configure a sequence, which shuts off power in the input side of the drive unit by the external thermal relay as shown below, to prevent overheat and burnout of the brake resistor (MRS type, MYS type) and high duty brake resistor (FR-ABR) in case the regenerative brake transistor is damaged. (The brake resistor cannot be connected to the 0.1K and 0.2K.)

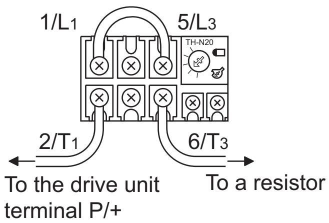




* Refer to the table below for the type number of each capacity of thermal relay and the diagram below for the connection.

Power Supply Voltage	Brake Resistor	Thermal Relay Type (Mitsubishi Product)	Contact Rating
200V	MRS120W200	TH-N20CXHZ-0.7A	AC110V 5A, AC220V 2A (AC11 class) DC110V 0.5A, DC220V 0.25A (DC11 class)
	MRS120W100	TH-N20CXHZ-1.3A	
	MRS120W60	TH-N20CXHZ-2.1A	
	MRS120W40	TH-N20CXHZ-3.6A	
	MYS220W50 (two units in parallel)	TH-N20CXHZ-5A	

Power Supply Voltage	High-duty Brake Resistor	Thermal Relay Type (Mitsubishi Product)	Contact Rating
200V	FR-ABR-0.4K	TH-N20CXHZ-0.7A	AC110V 5A, AC220V 2A (AC11 class) DC110V 0.5A, DC220V 0.25A (DC11 class)
	FR-ABR-0.75K	TH-N20CXHZ-1.3A	
	FR-ABR-2.2K	TH-N20CXHZ-2.1A	
	FR-ABR-3.7K	TH-N20CXHZ-3.6A	



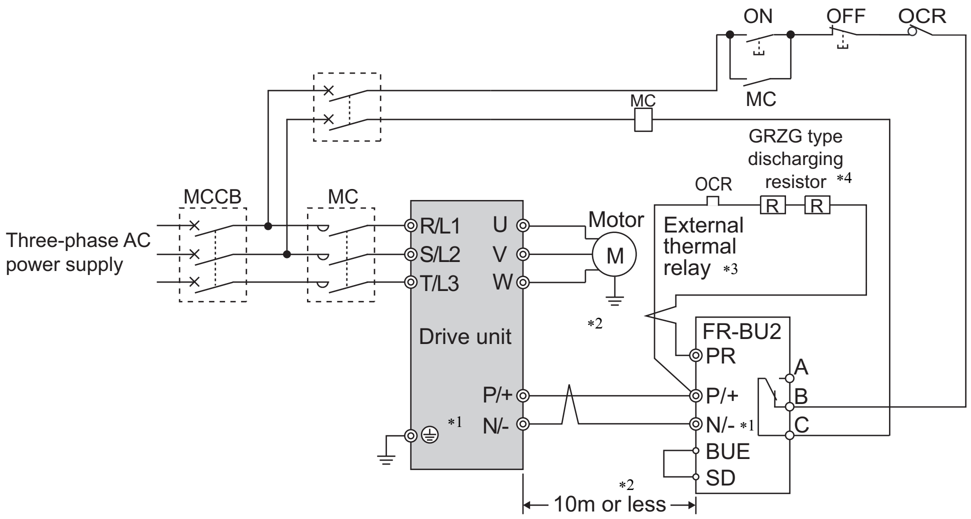
NOTE

- **The brake resistor connected should only be the dedicated brake resistor.**
- **Perform wiring and operation according to the Instruction Manual of each option unit.**
- **Brake resistor can not be used with the brake unit, high power factor converter, power supply regeneration converter, etc.**
- **Do not use the brake resistor (MRS type, MYS type) with a lead wire extended.**
- **Do not connect a resistor directly to the terminals P/+ and N/-. This could cause a fire.**

2.4.2 Connection of the brake unit (FR-BU2)

Connect the brake unit (FR-BU2) as shown below to improve the braking capability at deceleration. If the transistors in the brake unit should become faulty, the resistor can be unusually hot. To prevent unusual overheat and fire, install a magnetic contactor on the drive unit's input side to configure a circuit so that a current is shut off in case of fault.

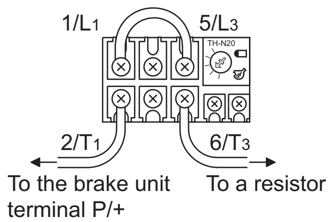
(1) Connection example with the GRZG type discharging resistor



*1 Connect the drive unit terminals (P/+ and N/-) and brake unit (FR-BU2) terminals so that their terminal names match with each other.
(Incorrect connection will damage the drive unit and brake unit.)
*2 The wiring distance between the drive unit, brake unit (FR-BU2) and discharging resistor should be within 5m. Even when the wiring is twisted, the cable length must not exceed 10m.
*3 It is recommended to install an external thermal relay to prevent overheat of discharging resistors.
*4 Refer to FR-BU2 manual for connection method of discharging resistor.

<Recommended external thermal relay>

Brake Unit	Discharging Resistor	Recommended External Thermal Relay
FR-BU2-1.5K	GZG 300W-50Ω (one)	TH-N20CXHZ 1.3A
FR-BU2-3.7K	GRZG 200-10Ω (three in series)	TH-N20CXHZ 3.6A



NOTE

- **Set "1" in *Pr.0 Brake mode selection* of the FR-BU2 to use GRZG type discharging resistor.**
- **Do not remove a jumper across terminal P/+ and P1 except when connecting a DC reactor (FR-HEL).**

2

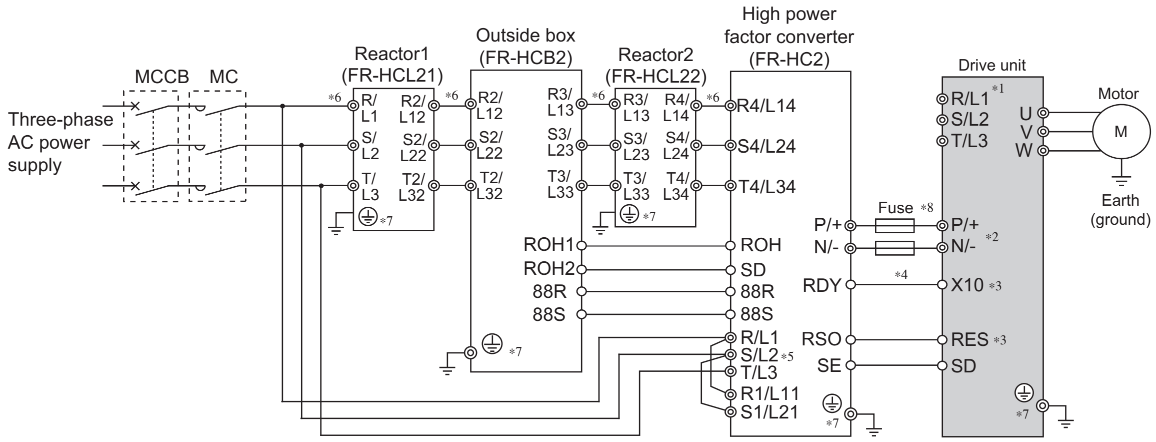
WIRING

2.4.3 Connection of the high power factor converter (FR-HC2)

When connecting the high power factor converter (FR-HC2) to suppress power harmonics, perform wiring securely as shown below. Incorrect connection will damage the high power factor converter and the drive unit.

Perform the wiring securely, and set the following parameter:

Pr.30 Regenerative function selection = "0" (Initial value).



*1 Do not connect anything to power input terminals (R/L1, S/L2, T/L3). Incorrect connection will damage the drive unit.

*2 Do not install an MCCB for the terminals P/+ and N/- (between terminals P and P/+ or between N and N/-). Connecting the opposite polarity of terminals N/- and P/+ will damage the drive unit.

*3 Assign the X10, RES signal to a terminal using any of *Pr.178 to Pr.189 (input terminal function selection)*. *(Refer to page 138)*

*4 Always connect the FR-HC2 terminal RDY to a terminal where the X10 or MRS signal is assigned in the drive unit. Always connect the FR-HC2 terminal SE to the drive unit terminal SD. Not connecting these terminals may damage the FR-HC2.

*5 Always connect the R/L1, S/L2, and T/L3 terminals of FR-HC2 to the power supply. Operating the drive unit without connecting them will damage FR-HC2.

*6 Do not install an MCCB or MC between the reactor 1 terminals (R/L1, S/L2, T/L3) and FR-HC2 terminals (R4/L14, S4/L24, T4/L34). It will not operate properly.

*7 Securely perform grounding (earthing) by using the ground (earth) terminal.

*8 Installation of a fuse is recommended. *(Refer to the Instruction Manual of FR-HC2.)*

NOTE

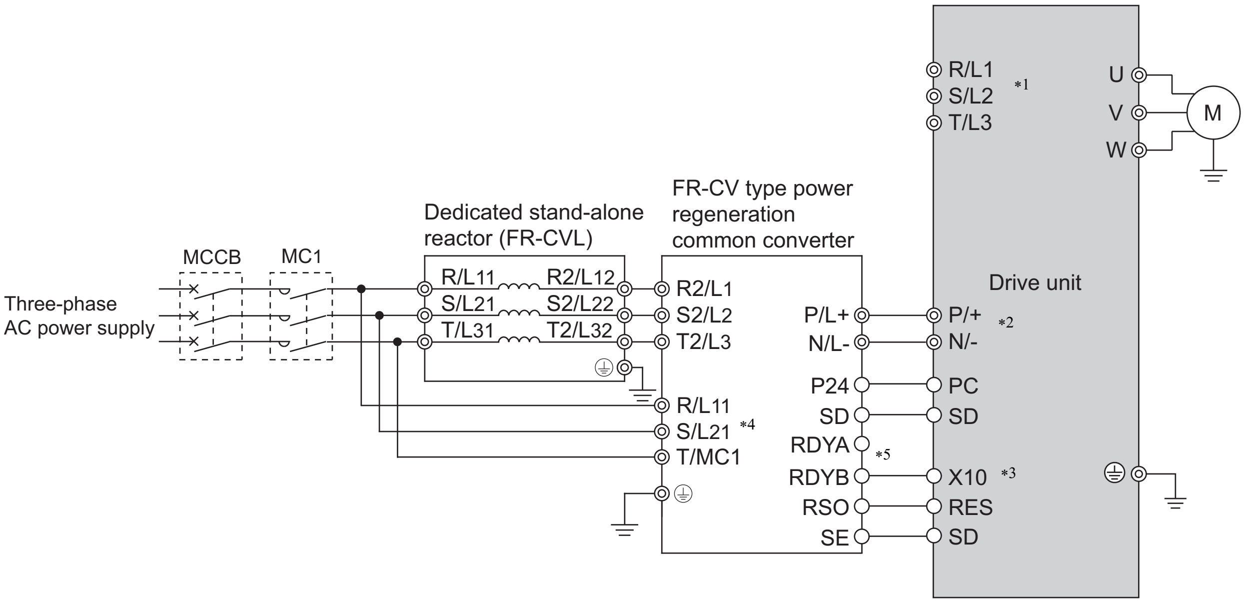
- **The voltage phases of terminals R/L1, S/L2, and T/L3 and the voltage phases of terminals R4/L14, S4/L24, and T4/L34 must be matched.**
- **Match the control logic (sink logic / source logic) of the FR-HC2 and the drive unit.** *(Refer to page 21)*
- **Do not connect a DC reactor (FR-HEL) to the drive unit when FR-HC2 is connected.**
- **A Filterpack cannot be connected when FR-HC2 is connected.**

Parameter referred to

Pr.30 Regenerative function selection ☞ *Refer to page 136*

2.4.4 Connection of the power regeneration common converter (FR-CV)

When connecting the power regeneration common converter (FR-CV), connect the drive unit terminals (P/+, N/-) and power regeneration common converter (FR-CV) terminals as shown below so that their symbols match with each other.



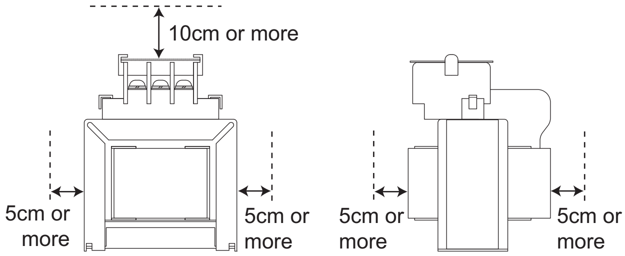
*1 Keep input terminals (R/L1, S/L2, T/L3) open. Incorrect connection will damage the drive unit.
*2 Do not insert an MCCB between the terminals P/+ and N/- (between P/L+ and P/+, between N/L- and N/-). Opposite polarity of terminals N/- and P/+ will damage the drive unit.
*3 Use *Pr.178 to Pr.184 (input terminal function selection)* to assign the terminals used for the X10, RES signal. *(Refer to page 138)*
*4 Always connect the power supply and terminals R/L11, S/L21, T/MC1.
Operating the drive unit without connecting them will damage the power regeneration common converter.
*5 Be sure to connect terminal RDYB of the FR-CV to the X10 signal or MRS signal assigned terminal of the drive unit, and connect terminal SE of the FR-CV to terminal SD of the drive unit. Without proper connecting, FR-CV will be damaged.

NOTE

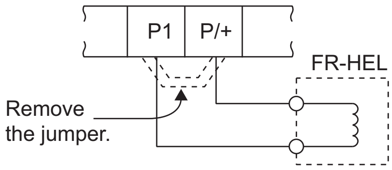
- **The voltage phases of terminals R/L11, S/L21, T/MC1 and terminals R2/L1, S2/L2, T2/L3 must be matched.**
- **Use sink logic (factory setting) when the FR-CV is connected. The FR-CV cannot be connected when source logic is selected.**
- **Do not connect a DC reactor (FR-HEL) to the drive unit when FR-CV is connected.**

2.4.5 Connection of the DC reactor (FR-HEL)

(1) Keep the surrounding air temperature within the permissible range (-10°C to +50°C). Keep enough clearance around the reactor because it heats up. (Take 10cm or more clearance on top and bottom and 5cm or more on left and right regardless of the installation direction.)



(2) When using the DC reactor (FR-HEL), connect it across terminals P/+ and P1.
In this case, the jumper connected across terminals P/+ and P1 must be removed. Otherwise, the reactor will not exhibit its performance.



(3) DC reactor (FR-HEL) is electrically connected to the enclosure through mounting screws when the DC reactor is securely mounted to the enclosure. If the DC reactor is not earthed (grounded) securely enough, an earthing (grounding) cable may be used.
When you are using an earthing (grounding) cable, wire the cable to the mounting hole where varnish is removed. (Refer to the Instruction Manual of FR-HEL.)

NOTE

- **The wiring distance should be within 5m.**
- **The size of the cables used should be equal to or larger than that of the power supply cables (R/L1, S/L2, T/L3) and the earthing (grounding) cable.** *(Refer to page 16)*
- **Do not connect a DC reactor (FR-HEL) to the drive unit when FR-HC2 or FR-CV is connected.**

3 PRECAUTIONS FOR USE OF THE DRIVE UNIT

This chapter explains the "PRECAUTIONS FOR USE OF THE DRIVE UNIT" for use of this product.
Always read the instructions before using the equipment.

3.1 EMC and leakage currents

3.1.1 Leakage currents and countermeasures

Capacitances exist between the drive unit I/O cables, other cables and earth and in the motor, through which a leakage current flows. Therefore, take the following measures. Select the earth leakage current breaker according to its rated sensitivity current, independently of the carrier frequency.

(1) To-earth (ground) leakage currents

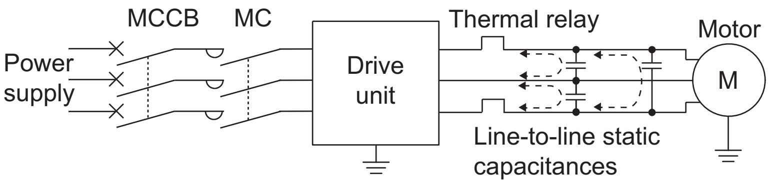
Leakage currents may flow not only into the drive unit's own line but also into the other lines through the earthing cable, etc. These leakage currents may operate earth (ground) leakage circuit breakers and earth leakage relays unnecessarily.

●Suppression technique

- Use an earth leakage circuit breaker with a weak sensitivity in the high frequency range.
  The output current of the drive unit contains a high-frequency leakage current component, which gives relatively low impacts to human bodies. The detention level for this high-frequency leakage current component can be set weaker to prevent unnecessary operations.
- Minimize the to-earth stray capacitance.
  Use the cables insulated with low dielectric constant material, and perform wiring to make the wiring length between the drive unit and the motor to be as short as possible.

(2) Line-to-line leakage currents

Harmonics of leakage currents flowing in static capacitances between the drive unit output cables may operate the external thermal relay unnecessarily.



Line-to-line leakage currents path

●Suppression technique

- Use *Pr.9 Electronic thermal O/L relay*.
- To ensure that the motor is protected against line-to-line leakage currents, it is recommended to use a temperature sensor to directly detect motor temperature.
- Increase the external thermal overload relay setting by the amount of the leakage current.
- Minimize the stray capacitance between the lines.
  Use the cables insulated with low dielectric constant material, and perform wiring to make the wiring length between the drive unit and the motor to be as short as possible.

●Installation and selection of moulded case circuit breaker

Install a moulded case circuit breaker (MCCB) on the power receiving side to protect the wiring of the drive unit input side. Select the MCCB according to the drive unit input side power factor (which depends on the power supply voltage, output frequency and load). Especially for a completely electromagnetic MCCB, one of a slightly large capacity must be selected since its operation characteristic varies with harmonic currents. (Check it in the data of the corresponding breaker.) As an earth leakage current breaker, use the Mitsubishi earth leakage current breaker designed for harmonics and surge suppression.

(3) Selection of rated sensitivity current of earth (ground) leakage current breaker

When using the earth leakage current breaker with the drive unit circuit, select its rated sensitivity current as follows, independently of the PWM carrier frequency.

- Breaker designed for harmonic and surge suppression
  Rated sensitivity current:
  $I\Delta n \geq 10 \times (Ig1+Ign+Igi+Ig2+Igm)$
- Standard breaker
  Rated sensitivity current:
  $I\Delta n \geq 10 \times \{Ig1+Ign+Igi+3 \times (Ig2+Igm)\}$

Ig1, Ig2: Leakage currents in wire path during commercial power supply operation

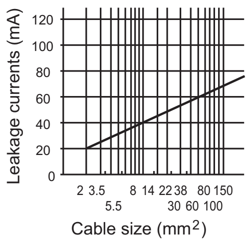
Ign: Leakage current of drive unit input side noise filter

Igm: Leakage current of motor.

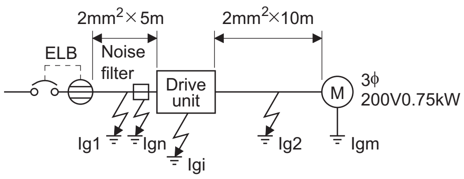
Motor		Leakage current (mA)
MM-GKR motor	0.1kW to 0.75kW	0
S-PM geared motor	0.1kW, 0.2kW	0
	0.4kW	0.06
	0.75kW	0.08
	1.5kW	0.13
	2.2kW	0.11

Igi: Leakage current of drive unit

Example of leakage current of cable path per 1km during the commercial power supply operation when the CV cable is routed in metal conduit
(200V 60Hz)



<Example>



	Breaker Designed for Harmonic and Surge Suppression	Standard Breaker
Leakage current Ig1 (mA)	$20 \times \frac{5m}{1000m} = 0.1$	
Leakage current Ign (mA)	0	
Leakage current Igi (mA)	1	
Leakage current Ig2 (mA)	$20 \times \frac{10m}{1000m} = 0.2$	
Motor leakage current Igm (mA)	0	
Total leakage current (mA)	1.3	1.7
Rated sensitivity current (mA) (≥Ig × 10)	15	30

NOTE

- **Install the earth leakage breaker (ELB) on the input side of the drive unit.**
- **In the ⅄ connection earthed-neutral system, the sensitivity current is blunt against an earth (ground) fault in the drive unit output side. Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 536 class 1 and other applicable standards)**
- **When the breaker is installed on the output side of the drive unit, it may be unnecessarily operated by harmonics even if the effective value is less than the rating.**
  In this case, do not install the breaker since the eddy current and hysteresis loss will increase, leading to temperature rise.
- **General products indicate the following models. ...... BV-C1, BC-V, NVB, NV-L, NV-G2N, NV-G3NA, NV-2F earth leakage relay (except NV-ZHA), NV with AA neutral wire open-phase protection**
  The other models are designed for harmonic and surge suppression ...... NV-C/NV-S/MN series, NV30-FA, NV50-FA, BV-C2, earth leakage alarm breaker (NF-Z), NV-ZHA, NV-H

3.1.2 EMC measures

Some electromagnetic noises enter the drive unit to malfunction it and others are radiated by the drive unit to malfunction peripheral devices. Though the drive unit is designed to have high immunity performance, it handles low-level signals, so it requires the following basic techniques. Also, since the drive unit chops outputs at high carrier frequency, that could generate electromagnetic noises. If these electromagnetic noises cause peripheral devices to malfunction, EMI measures should be taken to suppress noises. These techniques differ slightly depending on EMI paths.

(1) Basic techniques

- Do not run the power cables (I/O cables) and signal cables of the drive unit in parallel with each other and do not bundle them.
- Use twisted shield cables for the detector connecting and control signal cables and connect the sheathes of the shield cables to terminal SD.
- Earth (Ground) the drive unit, motor, etc. at one point.

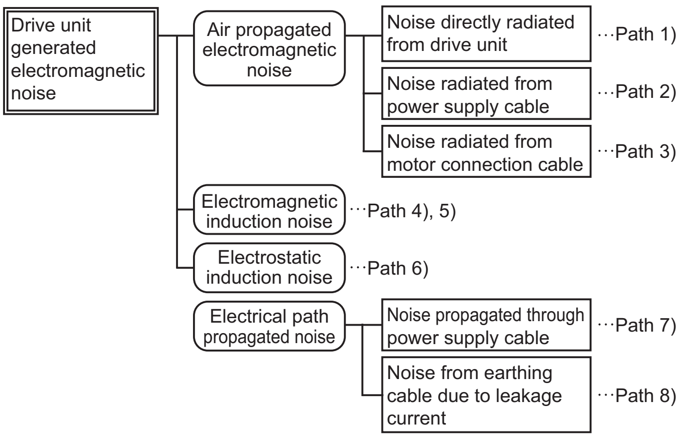
(2) Techniques to reduce electromagnetic noises that enter and malfunction the drive unit (Immunity measures)

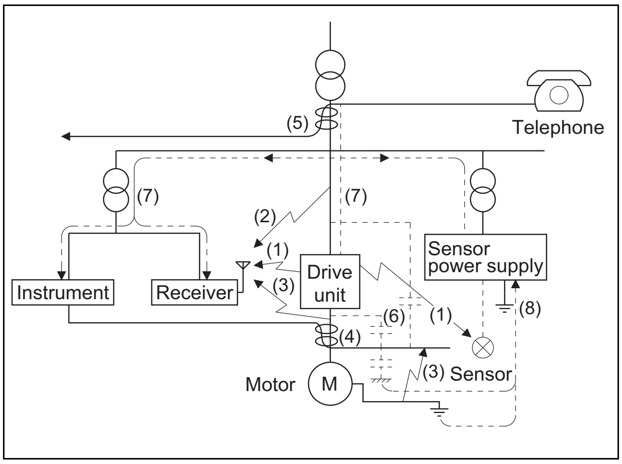
When devices that generate many electromagnetic noises (which use magnetic contactors, magnetic brakes, many relays, for example) are installed near the drive unit and the drive unit may be malfunctioned by electromagnetic noises, the following measures must be taken:

- Provide surge suppressors for devices that generate many electromagnetic noises to suppress electromagnetic noises.
- Fit data line filters *(page 37)* to signal cables.
- Earth (Ground) the shields of the detector connection and control signal cables with cable clamp metal.

(3) Techniques to reduce electromagnetic noises that are radiated by the drive unit to malfunction peripheral devices (EMI measures)

Drive unit-generated electromagnetic noises are largely classified into those radiated by the cables connected to the drive unit and drive unit main circuits (I/O), those electromagnetically and electrostatically induced to the signal cables of the peripheral devices close to the main circuit power supply, and those transmitted through the power supply cables.



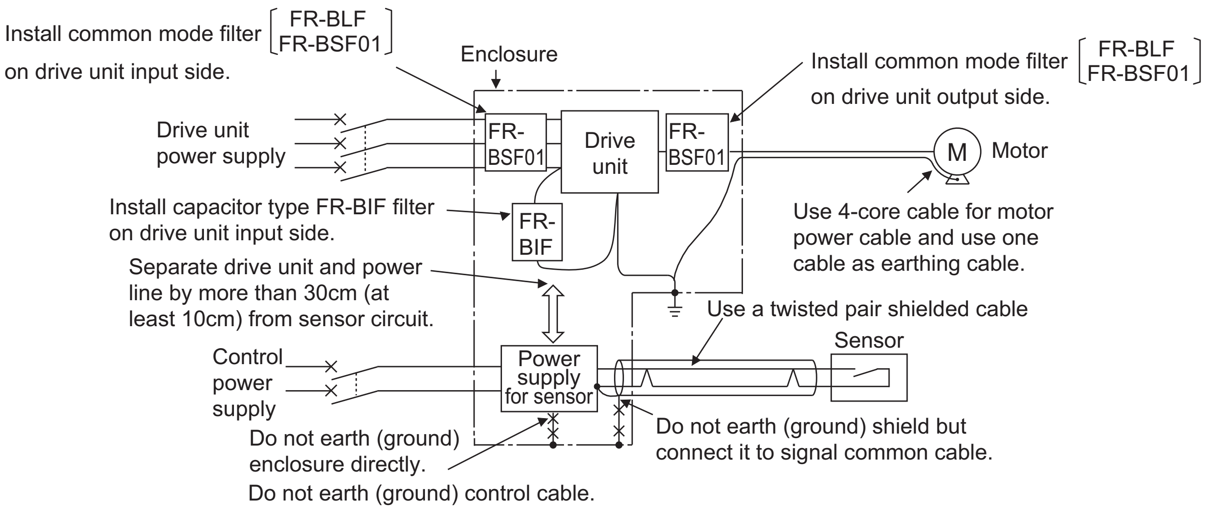


Propagation Path	Measures
(1)(2)(3)	When devices that handle low-level signals and are liable to malfunction due to electromagnetic noises, e.g. instruments, receivers and sensors, are contained in the enclosure that contains the drive unit or when their signal cables are run near the drive unit, the devices may malfunction due to air-propagated electromagnetic noises. The following measures must be taken: • Install easily affected devices as far away as possible from the drive unit. • Run easily affected signal cables as far away as possible from the drive unit and its I/O cables. • Do not run the signal cables and power cables (drive unit I/O cables) in parallel with each other and do not bundle them. • Insert common mode filters into I/O and capacitors between the input lines to suppress cable-radiated noises. • Use shield cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(4)(5)(6)	When the signal cables are run in parallel with or bundled with the power cables, magnetic and static induction noises may be propagated to the signal cables which cause the devices to malfunction and the following measures must be taken: • Install easily affected devices as far away as possible from the drive unit. • Run easily affected signal cables as far away as possible from the I/O cables of the drive unit. • Do not run the signal cables and power cables (drive unit I/O cables) in parallel with each other and do not bundle them. • Use shield cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(7)	When the power supplies of the peripheral devices are connected to the power supply of the drive unit in the same line, drive unit-generated noises may flow back through the power supply cables to malfunction the devices and the following measures must be taken: • Install the common mode filter (FR-BLF, FR-BSF01) to the power cables (output cable) of the drive unit.
(8)	When a closed loop circuit is formed by connecting the peripheral device wiring to the drive unit, leakage currents may flow through the earthing cable of the drive unit to malfunction the device. In such a case, disconnection of the earthing cable of the device may cause the device to operate properly.

●Data line filter

Data line filter is effective as an EMC measure. Provide a data line filter for the detector cable, etc.

●EMC measures



REMARKS

• For compliance with the EU EMC directive, please *refer the Instruction Manual (basic)*.

3.1.3 Power supply harmonics

The drive unit may generate power supply harmonics from its converter circuit to affect the power generator, power capacitor etc. Power supply harmonics are different from noise and leakage currents in source, frequency band and transmission path. Take the following countermeasure suppression techniques.

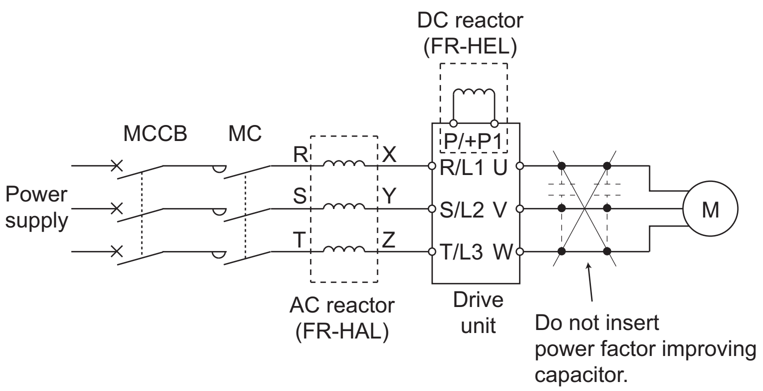
●The differences between harmonics and RF noises are indicated below:

Item	Harmonics	Noise
Frequency	Normally 40th to 50th degrees or less (up to 3kHz or less)	High frequency (several 10kHz to 1GHz order)
Environment	To-electric channel, power impedance	To-space, distance, wiring path
Quantitative understanding	Theoretical calculation possible	Random occurrence, quantitative grasping difficult
Generated amount	Nearly proportional to load capacity	Change with current variation ratio (larger as switching speed increases)
Affected equipment immunity	Specified in standard per equipment	Different depending on maker's equipment specifications
Suppression example	Provide reactor.	Increase distance.

●Suppression technique

The harmonic current generated from the drive unit to the input side differs according to various conditions such as the wiring impedance, whether a reactor is used or not, and output frequency and output current on the load side.

For the output frequency and output current, we understand that they should be calculated in the conditions under the rated load at the maximum operating frequency.



NOTE

The power factor improving capacitor and surge suppressor on the drive unit output side may be overheated or damaged by the harmonic components of the drive unit output. Also, since an excessive current flows in the drive unit to activate overcurrent protection, do not provide a capacitor and surge suppressor on the drive unit output side when the motor is driven by the drive unit. For power factor improvement, install a reactor on the drive unit input side or in the DC circuit.

3.1.4 Harmonic suppression guideline in Japan

Harmonic currents flow from the drive unit to a power receiving point via a power transformer. The harmonic suppression guideline was established to protect other consumers from these outgoing harmonic currents.

"Guideline for specific consumers"

This guideline sets forth the maximum values of harmonic currents outgoing from a high-voltage or especially high-voltage consumer who will install, add or renew harmonic generating equipment. If any of the maximum values are exceeded, this guideline requires the consumer to take certain suppression measures.

Table 1 Maximum Values of Outgoing Harmonic Currents per 1kW Contract Power

Received Power Voltage	5th	7th	11th	13th	17th	19th	23rd	Over 23rd
6.6kV	3.5	2.5	1.6	1.3	1.0	0.9	0.76	0.70
22kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36
33kV	1.2	0.86	0.55	0.46	0.35	0.32	0.26	0.24

(1) Application for specific consumers

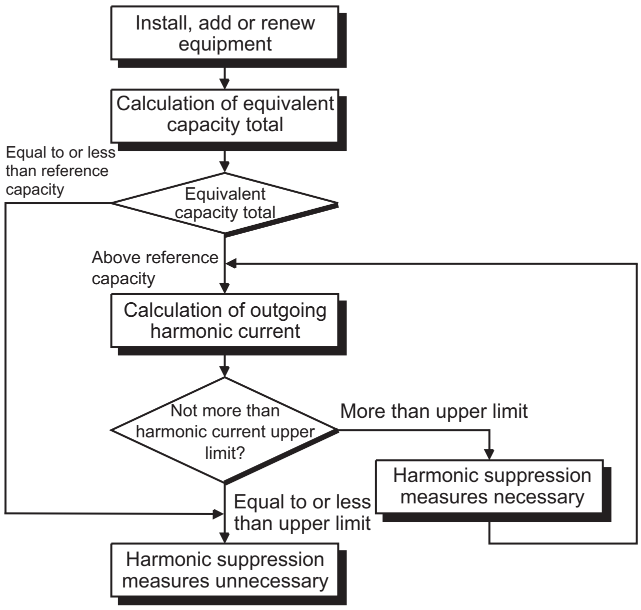


Table 2 Conversion Factors for FR-E700EX Series

Class	Circuit Type		Conversion Factor (Ki)
3	Three-phase bridge (Capacitor smoothing)	Without reactor	K31 = 3.4
		With reactor (AC side)	K32 = 1.8
		With reactor (DC side)	K33 = 1.8
		With reactors (AC, DC sides)	K34 = 1.4
5	Self-excitation three-phase bridge	When high power factor converter is used	K5 = 0

Table 3 Equivalent Capacity Limits

Received Power Voltage	Reference Capacity
6.6kV	50kVA
22/33kV	300kVA
66kV or more	2000kVA

Table 4 Harmonic Contents (Values at the fundamental current of 100%)

	Reactor	5th	7th	11th	13th	17th	19th	23rd	25th
Three-phase bridge (Capacitor smoothing)	Not used	65	41	8.5	7.7	4.3	3.1	2.6	1.8
	Used (AC side)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
	Used (DC side)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
	Used (AC, DC sides)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

1) Calculation of equivalent capacity (P0) of harmonic generating equipment

The "equivalent capacity" is the capacity of a 6-pulse converter converted from the capacity of consumer's harmonic generating equipment and is calculated with the following equation. If the sum of equivalent capacities is higher than the limit in Table 3, harmonics must be calculated with the following procedure:

$\underline{P0 = \Sigma(Ki \times Pi)}$ [kVA]

Ki: Conversion factor (refer to Table 2)

Pi: Rated capacity of harmonic generating equipment.* [kVA]

i: Number indicating the conversion circuit type

* Rated capacity: Determined by the capacity of the applied motor and found in Table 5. It should be noted that the rated capacity used here is used to calculate generated harmonic amount and is different from the power supply capacity required for actual drive unit drive.

2) Calculation of outgoing harmonic current

Outgoing harmonic current = fundamental wave current (value converted from received power voltage) × operation ratio × harmonic content

·Operation ratio: Operation ratio = actual load factor × operation time ratio during 30 minutes

·Harmonic content: Found in Table 4.

Table 5 Rated Capacities and Outgoing Harmonic Currents for Drive unit Drive

Applicable Motor (kW)	Rated Current [A]	Fundamental Wave Current Converted from 6.6kV (mA)	Rated Capacity (kVA)	Outgoing Harmonic Current Converted from 6.6kV(mA) (No reactor, 100% operation ratio)							
	200V			5th	7th	11th	13th	17th	19th	23rd	25th
0.1	0.61	18	0.22	11.7	7.38	1.53	1.386	0.774	0.558	0.468	0.324
0.2	0.98	30	0.35	19.5	12.3	2.55	2.31	1.29	0.93	0.78	0.54
0.4	1.61	49	0.57	31.85	20.09	4.165	3.773	2.107	1.519	1.274	0.882
0.75	2.74	83	0.97	53.95	34.03	7.055	6.391	3.569	2.573	2.158	1.494
1.5	5.50	167	1.95	108.6	68.47	14.20	12.86	7.181	5.177	4.342	3.006
2.2	7.93	240	2.81	156.0	98.40	20.40	18.48	10.32	7.440	6.240	4.320
3.7	13.0	394	4.61	257.1	161.5	33.49	30.34	16.94	12.21	10.24	7.092

3) Application of the guideline for specific consumers

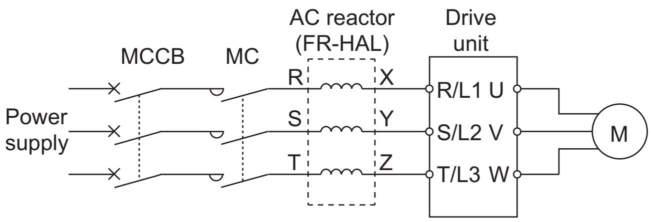
If the outgoing harmonic current is higher than the maximum value per 1kW contract power × contract power, a harmonic suppression technique is required.

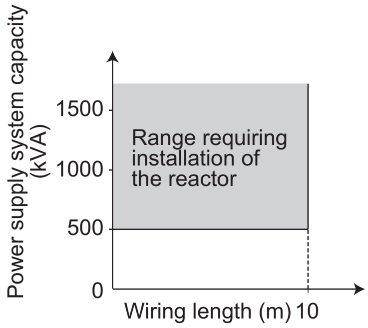
4) Harmonic suppression techniques

No.	Item	Description
1	Reactor installation (FR-HAL, FR-HEL)	Install an AC reactor (FR-HAL) on the AC side of the drive unit or a DC reactor (FR-HEL) on its DC side or both to suppress outgoing harmonic currents.
2	High power factor converter (FR-HC2)	This converter trims the current waveform to be a sine waveform by switching in the rectifier circuit (converter module) with transistors. Doing so suppresses the generated harmonic amount significantly. Connect it to the DC area of a drive unit. The high power factor converter (FR-HC2) is used with the standard accessory.
3	Installation of power factor improving capacitor	When used with a series reactor, the power factor improving capacitor has an effect of absorbing harmonic currents.
4	Transformer multi-phase operation	Use two transformers with a phase angle difference of 30° as in 人-Δ, Δ-Δ combination to provide an effect corresponding to 12 pulses, reducing low-degree harmonic currents.
5	Passive filter (AC filter)	A capacitor and a reactor are used together to reduce impedances at specific frequencies, producing a great effect of absorbing harmonic currents.
6	Active filter	This filter detects the current of a circuit generating a harmonic current and generates a harmonic current equivalent to a difference between that current and a fundamental wave current to suppress a harmonic current at a detection point, providing a great effect of absorbing harmonic currents.

3.2 Installation of a reactor

When the drive unit is connected near a large-capacity power transformer (500kVA or more) or when a power capacitor is to be switched over, an excessive peak current may flow in the power input circuit, damaging the converter circuit. To prevent this, always install an optional reactor (FR-HAL).
When connecting a single-phase 100V power input drive unit to a power transformer (50kVA or more), install an AC reactor (FR-HAL) so that the performance is more reliable.





3.3 Power-OFF and magnetic contactor (MC)

(1) Drive unit input side magnetic contactor (MC)

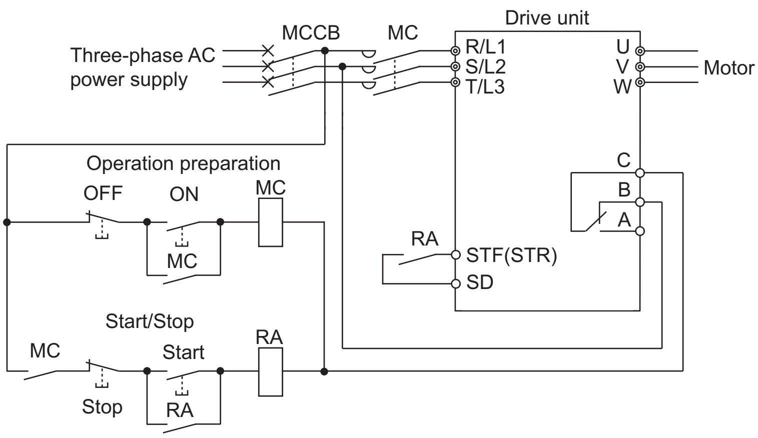
On the drive unit input side, it is recommended to provide an MC for the following purposes.
(Refer to *page 5* for selection.)

1) To release the drive unit from the power supply when the fault occurs or when the drive is not functioning (e.g. emergency stop operation). For example, MC avoids overheat or burnout of the brake resistor when heat capacity of the resistor is insufficient or brake regenerative transistor is damaged with short while connecting an optional brake resistor.
2) To prevent any accident due to an automatic restart at restoration of power after a drive unit stop by a power failure
3) To separate the drive unit from the power supply to ensure safe maintenance and inspection work.

If using an MC for emergency stop during operation, select an MC regarding the drive unit input side current as JEM1038-AC-3 class rated current.

REMARKS

- Since repeated inrush currents at power ON will shorten the life of the converter circuit (switching life is about 1,000,000 times.), frequent starts and stops of the magnetic contactor must be avoided. Turn ON/OFF the drive unit start controlling terminals (STF, STR) to run/stop the drive unit.



●Drive unit start/stop circuit example

As shown on the left, always use the start signal (ON or OFF of STF (STR) signal) to make a start or stop.

(2) Handling of drive unit output side magnetic contactor

Switch the magnetic contactor between the drive unit and motor only when both the drive unit and motor are at a stop. When the magnetic contactor is turned ON while the drive unit is operating, overcurrent protection of the drive unit and such will activate.

NOTE

- **A PM motor is a synchronous motor with embedded magnets. High-voltage is generated at motor terminals while the motor is running even after the drive unit power is turned OFF. Before wiring or inspection, the motor must be confirmed to be stopped. For applications where the motor is driven by the load, the low-voltage manual contactor, which is installed at the drive unit's output side, must be opened before wiring or inspection. Otherwise you may get an electric shock.**
- **Do not use a magnetic contactor at the drive unit's output side.**

3.4 Precautions for use of the drive unit

The FR-E700EX series is a highly reliable product, but using incorrect peripheral circuits or incorrect operation/handling methods may shorten the product life or damage the product.
Before starting operation, always recheck the following points.

(1) Use crimping terminals with insulation sleeve to wire the power supply and motor.

(2) Application of power to the output terminals (U, V, W) of the drive unit will damage the drive unit. Never perform such wiring.

(3) After wiring, wire offcuts must not be left in the drive unit.
Wire offcuts can cause an alarm, failure or malfunction. Always keep the drive unit clean.
When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the drive unit.

(4) Use cables of the appropriate size to make a voltage drop of 2% or less.
If the wiring distance is long between the drive unit and motor, a main circuit cable voltage drop will cause the motor torque to decrease especially at the output of a low speed.
Refer to page 16 for the recommended wire sizes.

(5) The wiring length should be 30m or less.

(6) Electromagnetic wave interference
The input/output (main circuit) of the drive unit includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the drive unit. In this case, install options among the capacitor type noise filter FR-BIF (for use in the input side only), the ferrite core type noise filter FR-BSF01/FR-BLF, Filterpack, and noise filter to minimize the interference.

(7) Do not install a power factor correction capacitor, surge suppressor or capacitor type filter on the drive unit output side.
This will cause the drive unit to trip or the capacitor and surge suppressor to be damaged. If any of the above devices are connected, immediately remove them.

(8) For some short time after the power is switched OFF, a high voltage remains in the smoothing capacitor.
When accessing the drive unit for inspection, wait for at least 10 minutes after the power supply has been switched OFF, and then make sure that the voltage across the main circuit terminals P/+ and N/- of the drive unit is no more than 30VDC using a tester, etc.

(9) Do not perform wiring or inspection while the 24 V external power is supplied.
When FR-E7DS is installed, if "EV" is displayed on the operation panel, turn OFF the 24 V external power supply before wiring and inspection. *(Refer to page 316)*

(10) A short circuit or earth (ground) fault on the drive unit output side may damage the inverter module.
- Fully check the insulation resistance of the circuit prior to drive unit operation since repeated short circuits may damage the inverter modules. These short circuits may be caused by peripheral circuit inadequacy, an earth (ground) fault caused by wiring inadequacy, or reduced motor insulation resistance.
- Fully check the to-earth (ground) insulation and phase to phase insulation of the drive unit output side before power-ON. Especially for an old motor or use in a hostile atmosphere, securely check the motor insulation resistance etc.

(11) Do not use the magnetic contactor at the drive unit input side to start/stop the drive unit.
Since repeated inrush currents at power ON will shorten the life of the converter circuit (switching life is about 1,000,000 times), frequent starts and stops of the MC must be avoided. Turn ON/OFF the drive unit start controlling terminals (STF, STR) to run/stop the drive unit. *(Refer to page 42)*

(12) Across terminals P/+ and PR, connect only an external brake resistor.

Do not connect a mechanical brake.
The brake resistor can not be connected to the 0.1K or 0.2K. Leave terminals P/+ and PR open.
Also, never short between these terminals.

(13) Do not apply a voltage higher than the permissible voltage to the drive unit I/O signal circuits.

Application of a voltage higher than the permissible voltage to the drive unit I/O signal circuits or opposite polarity may damage the I/O devices. Especially check the wiring to prevent the speed setting potentiometer from being connected incorrectly to short terminals 10 and 5.

(14) If the machine must not be restarted when power is restored after a power failure, provide a magnetic contactor in the drive unit's input side and also make up a sequence which will not switch ON the start signal.

If the start signal (start switch) remains ON after a power failure, the drive unit will automatically restart as soon as the power is restored.

(15) Drive unit input side magnetic contactor (MC)

On the drive unit input side, connect a MC for the following purposes. (Refer to *page 5* for selection.)

1) To release the drive unit from the power supply when a fault occurs or when the drive is not functioning (e.g. emergency stop operation). For example, MC avoids overheat or burnout of the brake resistor when heat capacity of the resistor is insufficient or brake regenerative transistor is damaged with short while connecting an optional brake resistor.
2) To prevent any accident due to an automatic restart at restoration of power after a drive unit stop made by a power failure
3) To separate the drive unit from the power supply to ensure safe maintenance and inspection work.

If using an MC for emergency stop during operation, select an MC regarding the drive unit input side current as JEM1038-AC-3 class rated current.

(16) Handling of magnetic motor starter at the drive unit output side

Do not install a magnetic contactor (MC) at the drive unit's output side.
In an application where the motor is driven by the load even after the drive unit is powered OFF, a manual contactor must be provided at the drive unit's output side. Do not open or close the manual contactor while the drive unit is running (outputting).

(17) Countermeasures against EMI generated by the drive unit

If electromagnetic noise generated from the drive unit causes speed setting signal to fluctuate and motor rotation speed to be unstable when changing motor rotation speed with analog signal, the following countermeasures are effective.

- Do not run the signal cables and power cables (drive unit I/O cables) in parallel with each other and do not bundle them.
- Run signal cables as far away as possible from power cables (drive unit I/O cables).
- Use shield cables as signal cables.
- Install a ferrite core on the signal cable (Example: ZCAT3035-1330 TDK).

(18) Instructions for overload operation

When performing operation of frequent start/stop of the drive unit, rise/fall in the temperature of the transistor element of the drive unit will repeat due to a repeated flow of large current, shortening the life from thermal fatigue. Since thermal fatigue is related to the amount of current, the life can be increased by reducing current at locked condition, starting current, etc. Decreasing current may increase the life. However, decreasing current will result in insufficient torque and the drive unit may not start. An effective measure is to use a drive unit and motor with higher capacities. Doing so will provide a margin to the load.

(19) Make sure that the specifications and rating match the system requirements.

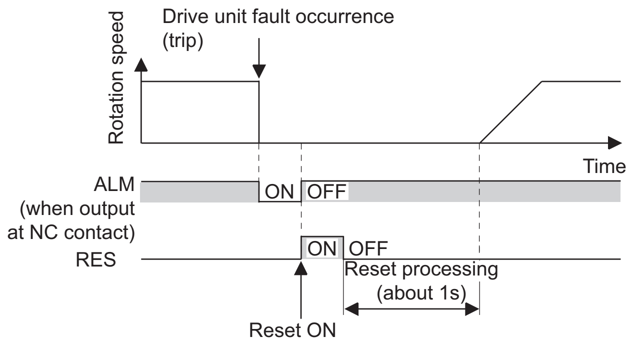
3.5 Failsafe of the system which uses the drive unit

When a fault occurs, the drive unit trips and outputs a fault signal. However, a fault signal may not be output at a drive unit fault occurrence when the detection circuit or output circuit fails, etc. Although Mitsubishi assures best quality products, provide an interlock which uses drive unit status output signals to prevent accidents such as damage to machine when the drive unit fails for some reason. At the same time, consider the system configuration where failsafe from outside the drive unit, without using the drive unit, is enabled in case the drive unit fails.

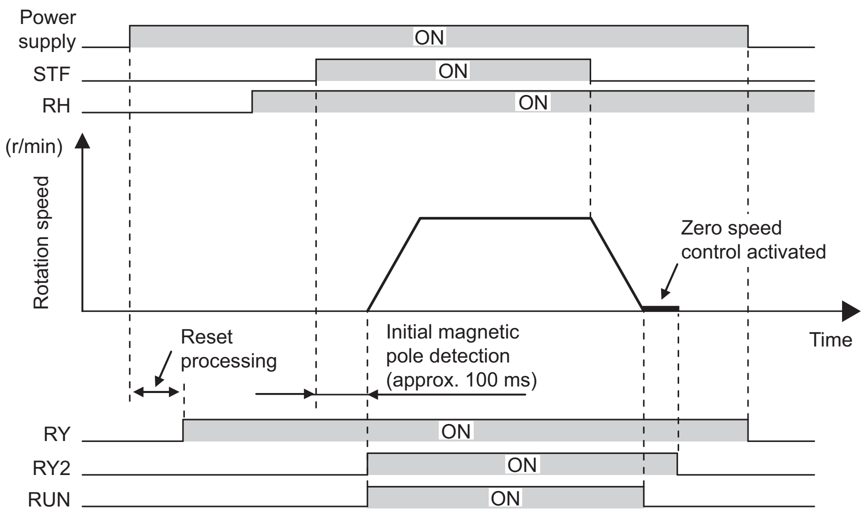
(1) Interlock method which uses the drive unit status output signals
By combining the drive unit status output signals to provide an interlock as shown below, a drive unit alarm can be detected.

No.	Interlock Method	Check Method	Used Signals	Refer to Page
1)	Drive unit protective function operation	Operation check of an alarm contact Circuit error detection by negative logic	Fault output signal (ALM signal)	*148*
2)	Drive unit running status	Operation ready signal check	Operation ready signal (RY signal)	*147*
3)	Drive unit running status	Logic check of the start signal and running signal	Start signal (STF signal, STR signal) Running signal (RUN signal)	*142, 147*
4)	Drive unit running status	Logic check of the start signal and output current	Start signal (STF signal, STR signal) Output current detection signal (Y12 signal)	*142, 150*

1)Check by the output of the drive unit fault signal
When the drive unit's protective function activates and the drive unit trips, the fault output signal (ALM signal) is output. (ALM signal is assigned to terminal ABC in the initial setting).
With this signal, you can check if the drive unit is operating properly.
In addition, negative logic can be set (ON when the drive unit is normal, OFF when the fault occurs).



2)Checking the drive unit operating status by the drive unit operation ready completion signal
Operation ready signal (RY signal) is output when the drive unit power is on and the drive unit becomes operative.
Check if the RY signal is output after power-ON the drive unit.



3)Checking the drive unit operating status by the start signal input to the drive unit and drive unit running signal.
The drive unit running signal (RUN signal) is output when the drive unit is running (RUN signal is assigned to terminal RUN in the initial setting).

Check if RUN signal is output when inputting the start signal to the drive unit (forward signal is STF signal and reverse signal is STR signal). For logic check, note that RUN signal is output for the period from the drive unit decelerates until output to the motor is stopped, configure a sequence considering the drive unit deceleration time

Output signal	*Pr.190 to Pr.192* Setting	
	Positive logic	Negative logic
ALM	99	199
RY	11	111
RUN	0	100

· When using various signals, assign functions to *Pr.190 to Pr.192 (output terminal function selection)* referring to the table on the left.

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

(2) Backup method outside the drive unit

Even if the interlock is provided by the drive unit status signal, enough failsafe is not ensured depending on the failure status of the drive unit itself. For example, when the drive unit CPU fails, even if the interlock is provided using the drive unit fault output signal, start signal and RUN signal output, there is a case where a fault output signal is not output and RUN signal is kept output even if a drive unit fault occurs.

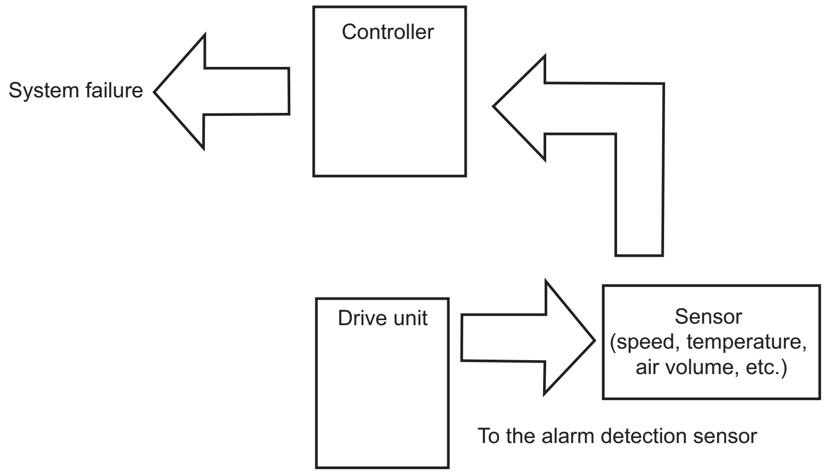
Provide a speed detector to detect the motor speed and current detector to detect the motor current and consider the backup system such as checking up as below according to the level of importance of the system.

1) Start signal and actual operation check

Check the motor running and motor current while the start signal is input to the drive unit by comparing the start signal to the drive unit and detected speed of the speed detector or detected current of the current detector. Note that the motor current runs as the motor is running for the period until the motor stops since the drive unit starts decelerating even if the start signal turns off. For the logic check, configure a sequence considering the drive unit deceleration time. In addition, it is recommended to check the three-phase current when using the current detector.

2) Command speed and actual operation check

Check if there is no gap between the actual speed and commanded speed by comparing the drive unit speed command and detected speed of the speed detector.



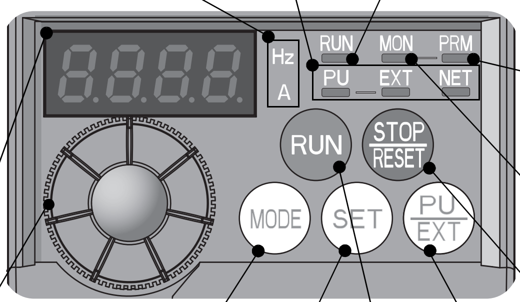
4 PARAMETERS

This chapter explains the "PARAMETERS" for use of this product.
Always read the instructions before using the equipment.

4.1 Operation panel

4.1.1 Names and functions of the operation panel

The operation panel cannot be removed from the drive unit.



Operation mode indicator
PU: ON to indicate PU operation mode.
EXT: ON to indicate External operation mode.
(ON at power-ON at initial setting.)
NET: ON to indicate Network operation mode.
PU, EXT: ON to indicate External/PU combined operation mode 1, 2.
These turn OFF when command source is not on operation panel.

Unit indicator
- Hz: ON to indicate frequency. (Flickers when the set frequency monitor is displayed.)
- A: ON to indicate current.

(Both "Hz" and "A" turn OFF when other than the above is displayed.)

Monitor (4-digit LED)
Shows the speed, parameter number, etc.

Setting dial
(Setting dial: Mitsubishi drive unit dial)
Used to change the speed setting and parameter settings.
Press to display the following.
- Displays the set speed in the monitor mode
- Present set value is displayed during calibration
- Displays the order in the faults history mode

Mode switchover
Used to change each setting mode.
Pressing (PU/EXT) simultaneously changes the operation mode. *(Refer to page 50)*
Pressing for a while (2s) can lock operation. The key lock is invalid when *Pr. 161* = "0 (initial setting)".
(Refer to page 256)

Monitor setting
If pressed during operation, the monitor changes as below:

Rotation speed → Output current → Output voltage → (back to Rotation speed)

Operating status indicator
ON or flicker during drive unit operation. *
* ON: When the forward rotation operation is being performed.
Slow flickering (1.4s cycle): When the reverse operation is being performed.
Fast flickering (0.2s cycle): When (RUN) was pressed or the start command was given, but the operation cannot be made.
When the MRS signal is input.)

Parameter setting mode
ON to indicate parameter setting mode.

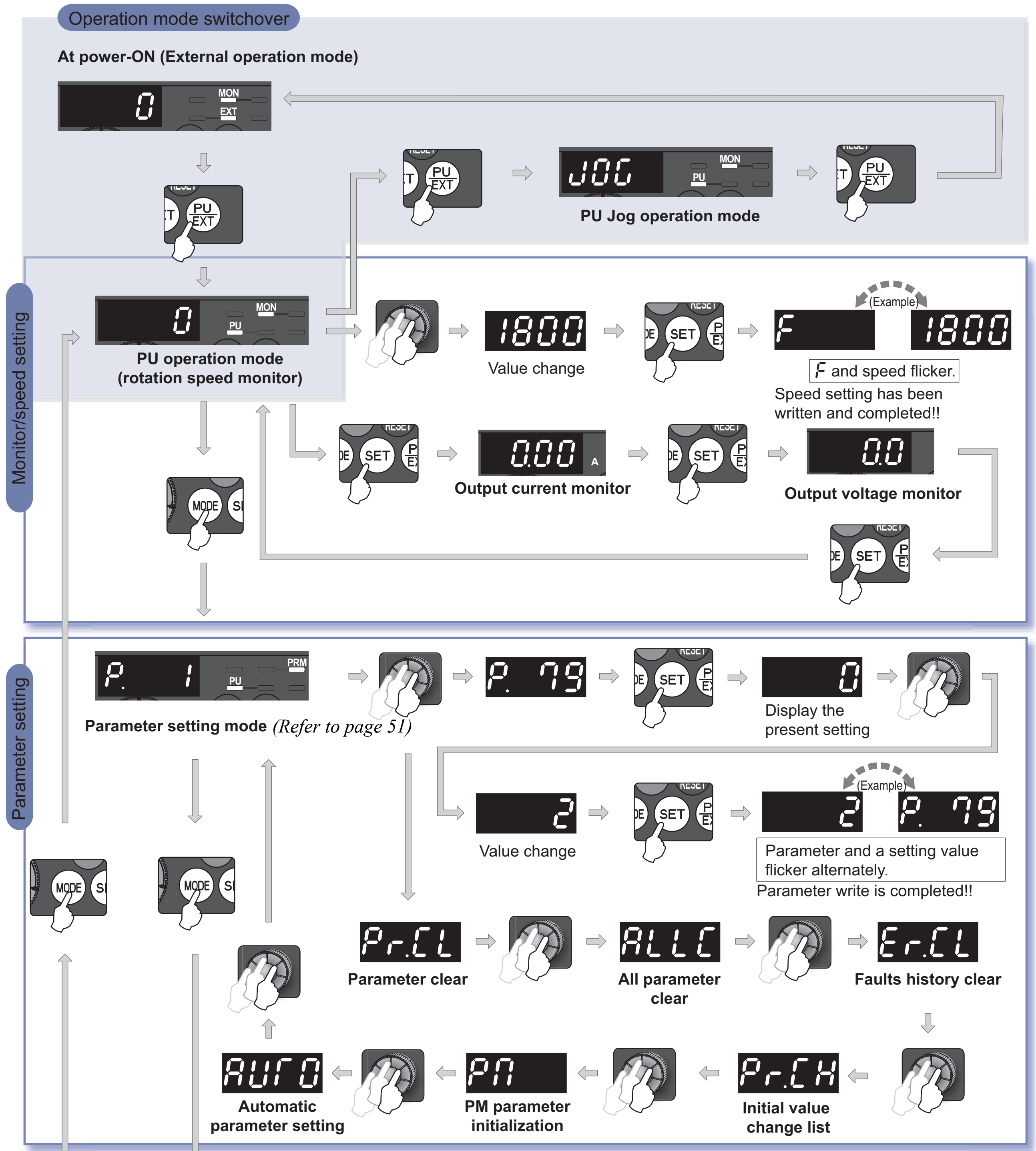
Monitor indicator
ON to indicate monitoring mode.

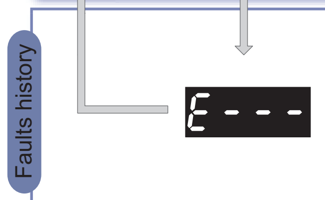
Stop operation
Used to stop Run command.
Fault can be reset when protective function is activated (fault).

Operation mode switchover
Used to switch between the PU and External operation mode.
When using the External operation mode (operation using a separately connected speed setting potentiometer and start signal), press this key to light up the EXT indicator.
(Press (MODE) simultaneously (0.5s) or *(Refer to page 50)* change *Pr. 79* setting to change to combined mode.)
PU: PU operation mode.
EXT: External operation mode. Cancels PU stop also.

Start command
The rotation direction can be selected by setting *Pr. 40*.

4.1.2 Basic operation (factory setting)





[Operation for displaying faults history] *(Refer to page 263)*

Past eight faults can be displayed.

(The latest fault is ended by ".".)

When no fault history exists, E 0 is displayed.

While a fault is displayed:

- The display shifts as follows by pressing (SET) : Rotation speed at the fault → Output current → Output voltage → Energization time.
  (After Energization time, it goes back to a fault display.)
- Pressing the setting dial shows the fault history number.

4

PARAMETERS

4.1.3 Easy operation mode setting (easy setting mode)

Setting of *Pr.79 Operation mode selection* according to combination of the start command and speed command can be easily made.

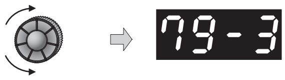
Operation example	Start command: external (STF/STR), speed command: operate with (dial)

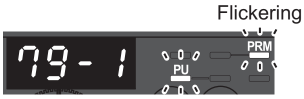
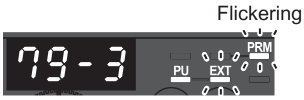
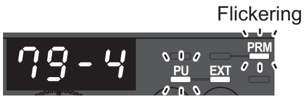
Operation — **Display**

1. Screen at power-ON
   The monitor display appears.

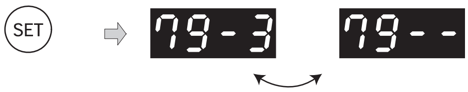
2. Press (PU/EXT) and (MODE) for 0.5s.

3. Turn (dial) until 79-3 appears.
   (refer to the table below for other settings)

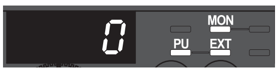


Operation Panel Indication	Operation Method	
	Start command	Speed command
 Flickering / 79-1 / Flickering	RUN	
 Flickering / 79-2 / Flickering	External (STF, STR)	Analog voltage input
 Flickering / 79-3 / Flickering	External (STF, STR)	
 Flickering / 79-4 / Flickering	RUN	Analog voltage input

4. Press (SET) to set.



Flicker ··· Parameter setting complete!!
The monitor display appears after 3s.



REMARKS

? Er2 is displayed ... Why?
☞ Setting can not be made during operation. Turn the start switch ((RUN), STF or STR) OFF.

- If (MODE) is pressed before pressing (SET), the easy setting mode is terminated and the display goes back to the monitor display. If the easy setting mode is terminated while *Pr.79* = "0 (initial setting)," the operation mode switches between the PU operation mode and the External operation mode. Check the operation mode.
- Reset can be made with (STOP/RESET).
- The priorities of the speed commands when *Pr.79* = "3" are "Multi-speed operation (RL/RM/RH/REX) > PID control (X14) > terminal 4 analog input (AU) > digital input from the operation panel".

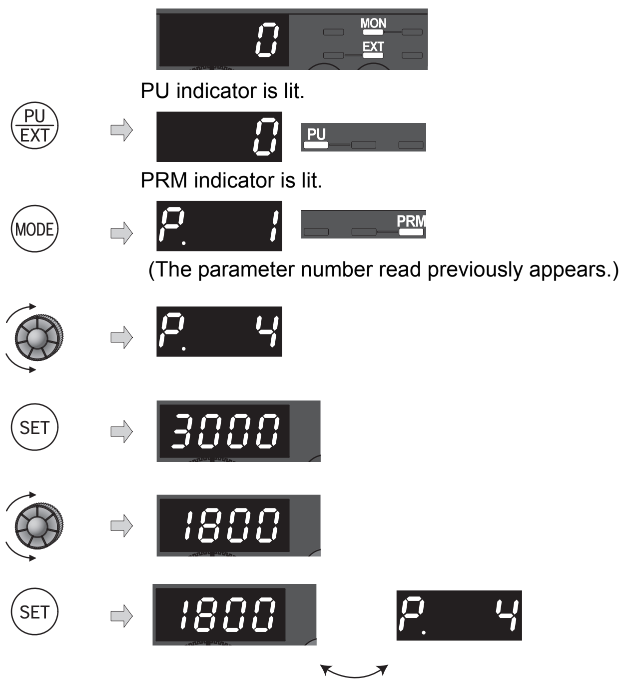
4.1.4 Changing the parameter setting value

Changing example	Change the *Pr.4 Multi-speed setting (high speed)* setting.

Operation

1. Screen at power-ON
   The monitor display appears.
2. Press (PU/EXT) to choose the PU operation mode.
3. Press (MODE) to choose the parameter setting mode.
4. Turn until P. 4 *(Pr.4)* appears.
5. Press (SET) to read the currently set value.
   "3000" (3000r/min (initial value)) appears.
6. Turn to change the set value to "1800" (1800r/min).
7. Press (SET) to set.

Display



Flicker...Parameter setting complete!!

- Turn to read another parameter.
- Press (SET) to show the setting again.
- Press (SET) twice to show the next parameter.
- Press (MODE) twice to return the monitor to speed monitor.

REMARKS

? Er1 to Er4 is displayed...Why?

Er1 appears .... Write disable error
Er2 appears .... Write error during operation
Er3 appears .... Calibration error
Er4 appears .... Mode designation error

(For details, refer to *page 268*.)

- The number of digits displayed on the operation panel is four. Only the upper four digits of values can be displayed and set. If the values to be displayed have five digits or more including decimal places, the fifth or later numerals can not be displayed nor set.
  (Example) For Pr.1 (when *Pr.144* = "10 (frequency setting)")
  When 60Hz is set, 60.00 is displayed.
  When 120Hz is set, 120.0 is displayed and second decimal place is not displayed nor set.

4.1.5 Displaying the set speed

Press the setting dial ( ) in the PU operation mode or in the External/PU combined operation mode 1 (*Pr.79* = "3") to show the set speed.

Parameter list

4.2 Parameter list

4.2.1 Parameter list

For simple variable-speed operation of the inverter, the initial setting of the parameters may be used as they are. Set the necessary parameters to meet the load and operational specifications. Parameter setting, change and check are available from the operation panel.

REMARKS

- ◎ indicates simple mode parameters. (initially set to extended mode)
- The parameters surrounded by a black border in the table allow its setting to be changed during operation even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

- Symbol in the Remarks column.

  Ver.UP ...Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.
- Symbols in the table indicate parameters which function when an option is mounted.

  NC ....FR-A7NC E kit
- These instruction codes are used for parameter read and write by using Mitsubishi inverter protocol with the RS-485 communication. (*Refer to page 204* for RS-485 communication)
- "○" indicates valid and "×" indicates invalid of "control mode-based correspondence table", "parameter copy", "parameter clear", and "all parameter clear".

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Basic functions	◎ 1	Maximum setting	0 to 4800r/min *1	1r/min	3000r/min	115	
	◎ 2	Minimum setting	0 to 4800r/min *1	1r/min	0r/min	115	
	◎ 4	Multi-speed setting (high speed)	0 to 4800r/min *1	1r/min	3000r/min	117, 95	
	◎ 5	Multi-speed setting (middle speed)	0 to 4800r/min *1	1r/min	1500r/min	117, 95	
	◎ 6	Multi-speed setting (low speed)	0 to 4800r/min *1	1r/min	300r/min	117, 95	
	◎ 7	Acceleration time	0 to 360s	0.01s	5s	125	
	◎ 8	Deceleration time	0 to 360s	0.01s	5s	125	
	◎ 9	Electronic thermal O/L relay	0 to 500A	0.01A	Rated motor current *9	130	
DC injection brake	10	Coasting speed	0 to 4800r/min *1	1r/min	90r/min	131	
	11	DC injection brake operation time	0 to 10s	0.1s	0.5s	131	
—	13	Starting speed	0 to 4800r/min *1	1r/min	15r/min	128	
JOG operation	15	Jog speed setting	0 to 4800r/min *1	1r/min	150r/min	119	
	16	Jog acceleration/deceleration time	0 to 360s	0.01s	0.5s	119	
—	17	MRS input selection	0, 2, 4	1	0	140	
Acceleration/ deceleration time	20	Acceleration/deceleration reference speed	12 to 4800r/min *1	1r/min	3000r/min	125	
Torque limit	22	Torque limit level	0 to 200%, 9999	0.1%	200/150% *2	111	
Multi-speed setting	24	Multi-speed setting (speed 4)	0 to 4800r/min *1, 9999	1r/min	9999	117, 95	
	25	Multi-speed setting (speed 5)	0 to 4800r/min *1, 9999	1r/min	9999	117, 95	
	26	Multi-speed setting (speed 6)	0 to 4800r/min *1, 9999	1r/min	9999	117, 95	
	27	Multi-speed setting (speed 7)	0 to 4800r/min *1, 9999	1r/min	9999	117, 95	
—	29	Acceleration/deceleration pattern selection	0, 1, 2	1	0	129	
—	30	Regenerative function selection	0, 1	1	0	136	
Speed jump	31	Speed jump 1A	0 to 4800r/min *1, 9999	1r/min	9999	116	
	32	Speed jump 1B	0 to 4800r/min *1, 9999	1r/min	9999	116	
	33	Speed jump 2A	0 to 4800r/min *1, 9999	1r/min	9999	116	
	34	Speed jump 2B	0 to 4800r/min *1, 9999	1r/min	9999	116	
	35	Speed jump 3A	0 to 4800r/min *1, 9999	1r/min	9999	116	
	36	Speed jump 3B	0 to 4800r/min *1, 9999	1r/min	9999	116	
—	37	Speed display	0, 0.01 to 9998	0.001	0	153	
—	40	RUN key rotation direction selection	0, 1	1	0	255	
Speed detection	41	Up-to-speed sensitivity	0 to 100%	0.1%	10%	149	
	42	Speed detection	0 to 4800r/min *1	1r/min	180r/min	149	
	43	Speed detection for reverse rotation	0 to 4800r/min *1, 9999	1r/min	9999	149	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
◎ 1		01	81	0	○	○	○	○	○	○
◎ 2		02	82	0	○	○	×	○	○	○
◎ 4		04	84	0	○	○	○	○	○	○
◎ 5		05	85	0	○	○	○	○	○	○
◎ 6		06	86	0	○	○	○	○	○	○
◎ 7		07	87	0	○	○	○	○	○	○
◎ 8		08	88	0	○	○	○	○	○	○
◎ 9		09	89	0	○	○	○	○	○	○
10		0A	8A	0	○	○	×	○	○	○
11		0B	8B	0	○	○	×	○	○	○
13		0D	8D	0	○	○	×	○	○	○
15		0F	8F	0	○	○	○	○	○	○
16		10	90	0	○	○	○	○	○	○
17		11	91	0	○	○	○	○	○	○
20		14	94	0	○	○	○	○	○	○
22	Ver.UP	16	96	0	○	○	○	○	○	○
24		18	98	0	○	○	○	○	○	○
25		19	99	0	○	○	○	○	○	○
26		1A	9A	0	○	○	○	○	○	○
27		1B	9B	0	○	○	○	○	○	○
29		1D	9D	0	○	○	×	○	○	○
30		1E	9E	0	○	○	○	○	○	○
31		1F	9F	0	○	○	×	○	○	○
32		20	A0	0	○	○	×	○	○	○
33		21	A1	0	○	○	×	○	○	○
34		22	A2	0	○	○	×	○	○	○
35		23	A3	0	○	○	×	○	○	○
36		24	A4	0	○	○	×	○	○	○
37		25	A5	0	○	○	○	○	○	○
40		28	A8	0	○	○	○	○	○	○
41		29	A9	0	○	○	×	○	○	○
42		2A	AA	0	○	○	○	○	○	○
43		2B	AB	0	○	○	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Secind functions	44	Second acceleration/deceleration time	0 to 360s	0.01s	5s	125	
Secind functions	45	Second deceleration time	0 to 360s, 9999	0.01s	9999	125	
Secind functions	48	Second torque limit level	0 to 200%, 9999	0.1%	9999	111	
Monitor functions	52	DU/PU main display data selection	0, 5, 8 to 12, 14, 19, 20, 23 to 31, 36, 37, 52 to 55, 61, 62, 100	1	0	155	
Monitor functions	54	FM terminal function selection	1 to 3, 5, 8 to 12, 14, 21, 24, 36, 37, 52, 53, 61, 62	1	1	155	
Monitor functions	55	Speed monitoring reference	0 to 4800r/min *1	1r/min	3000r/min	161	
Monitor functions	56	Current monitoring reference	0 to 500A	0.01A	Rated motor current *9	161	
—	59	Remote function selection	0, 1, 2, 3	1	0	122	
—	65	Retry selection	0 to 5	1	0	164	
Retry	67	Number of retries at fault occurrence	0 to 10, 101 to 110	1	0	164	
Retry	68	Retry waiting time	0.1 to 360s	0.1s	1s	164	
Retry	69	Retry count display erase	0	1	0	164	
—	70	Special regenerative brake duty	0 to 30%	0.1%	0%	136	
—	71 *15	Parameter for manufacturer setting. These parameters will not be displayed.					
—	72 *15						
—	73	Analog input selection	0, 1, 10, 11	1	1	168	
—	74	Input filter time constant	0 to 8	1	1	172	
—	75	Reset selection/disconnected PU detection/PU stop selection	0 to 3, 14 to 17	1	14	178	
—	77	Parameter write selection	0, 1, 2	1	0	181	
—	78	Reverse rotation prevention selection	0, 1, 2	1	0	182	
—	◎ 79	Operation mode selection	0, 1, 2, 3, 4, 6, 7	1	0	186, 194	
—	80 *15	Parameter for manufacturer setting. These parameters will not be displayed.					
Home position return	110	Acceleration time for home position return	0.01 to 360s	0.01s	5s	104	
Home position return	111	Deceleration time for home position return	0.01 to 360s	0.01s	5s	104	
PU connector communication	117 *11	PU communication station number	0 to 31 (0 to 247)	1	0	204, 222	
PU connector communication	118 *11	PU communication speed	48, 96, 192, 384	1	192	204, 222	
PU connector communication	119 *11	PU communication stop bit length	0, 1, 10, 11	1	1	204	
PU connector communication	120 *11	PU communication parity check	0, 1, 2	1	2	204, 222	
PU connector communication	121	Number of PU communication retries	0 to 10, 9999	1	1	205	
PU connector communication	122	PU communication check time interval	0, 0.1 to 999.8s, 9999	0.1s	0	205, 222	
PU connector communication	123 *11	PU communication waiting time	0 to 150ms, 9999	1	9999	204	
PU connector communication	124 *11	PU communication CR/LF selection	0, 1, 2	1	1	204	
—	◎ 125	Terminal 2 speed setting gain speed	0 to 4800r/min *1	1r/min	3000r/min	173	
—	◎ 126	Terminal 4 speed setting gain speed	0 to 4800r/min *1	1r/min	3000r/min	173	
PID operation	127	PID control automatic switchover speed	0 to 4800r/min, 9999	1r/min	9999	235	
PID operation	128	PID action selection	0, 20, 21, 50, 51, 60, 61	1	0	235	
PID operation	129	PID proportional band	0.1 to 1000%, 9999	0.1%	100%	235	
PID operation	130	PID integral time	0.1 to 3600s, 9999	0.1s	1s	235	
PID operation	131	PID upper limit	0 to 100%, 9999	0.1%	9999	235	
PID operation	132	PID lower limit	0 to 100%, 9999	0.1%	9999	235	
PID operation	133	PID action set point	0 to 100%, 9999	0.01%	9999	235	
PID operation	134	PID differential time	0.01 to 10s, 9999	0.01s	9999	235	
—	144	Speed setting switchover	2, 4, 6, 8, 10, 102, 104, 106, 108, 110	1	110/104/106 *3	153	
—	147	Acceleration/deceleration time switching speed	0 to 4800r/min *1, 9999	1r/min	9999	125	
—	148	Torque limit level at 0mA input	0 to 200%	0.1%	150%	111	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
44		2C	AC	0	○	○	○	○	○	○
45		2D	AD	0	○	○	○	○	○	○
48		30	B0	0	○	○	○	○	○	○
52		34	B4	0	○	○	○	○	○	○
54		36	B6	0	○	○	○	○	○	○
55		37	B7	0	○	○	○	○	○	○
56		38	B8	0	○	○	○	○	○	○
59		3B	BB	0	○	○	×	○	○	○
65		41	C1	0	○	○	×	○	○	○
67		43	C3	0	○	○	×	○	○	○
68		44	C4	0	○	○	×	○	○	○
69		45	C5	0	○	○	×	○	○	○
70		46	C6	0	○	○	○	○	○	○
71	Parameter for manufacturer setting. These parameters will not be displayed.									
72										
73		49	C9	0	○	○	×	○	×	○
74		4A	CA	0	○	○	○	○	○	○
75		4B	CB	0	○	○	○	○	×	×
77		4D	CD *12	0	○	○	○	○	○	○
78		4E	CE	0	○	○	○	○	○	○
◎ 79		4F	CF *12	0	○	○	○	○	○	○
80	Parameter for manufacturer setting. These parameters will not be displayed.									
110		0A	8A	1	×	×	○	○	○	○
111		0B	8B	1	×	×	○	○	○	○
117		11	91	1	○	○	○	○	○ *13	○ *13
118		12	92	1	○	○	○	○	○ *13	○ *13
119		13	93	1	○	○	○	○	○ *13	○ *13
120		14	94	1	○	○	○	○	○ *13	○ *13
121		15	95	1	○	○	○	○	○ *13	○ *13
122		16	96	1	○	○	○	○	○ *13	○ *13
123		17	97	1	○	○	○	○	○ *13	○ *13
124		18	98	1	○	○	○	○	○ *13	○ *13
◎ 125		19	99	1	○	○	×	○	×	○
◎ 126		1A	9A	1	○	○	×	○	×	○
127		1B	9B	1	○	○	×	○	○	○
128		1C	9C	1	○	○	×	○	○	○
129		1D	9D	1	○	○	×	○	○	○
130		1E	9E	1	○	○	×	○	○	○
131		1F	9F	1	○	○	×	○	○	○
132		20	A0	1	○	○	×	○	○	○
133		21	A1	1	○	○	×	○	○	○
134		22	A2	1	○	○	×	○	○	○
144		2C	AC	1	○	○	○	○	○	○
147		2F	AF	1	○	○	×	○	○	○
148		30	B0	1	○	○	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
—	149	Torque limit level at 20mA input	0 to 200%	0.1%	200%	111	
Current detection	150	Output current detection level	0 to 200%	0.1%	150%	150	
	151	Output current detection signal delay time	0 to 10s	0.1s	0s	150	
	152	Zero current detection level	0 to 200%	0.1%	5%	150	
	153	Zero current detection time	0 to 1s	0.01s	0.5s	150	
—	156	Torque limit selection	0 to 31, 100, 101	1	0	111	
—	157	OL signal output timer	0 to 25s, 9999	0.1s	0s	111	
—	◎ 160	Extended function display selection	0, 9999	1	0	182	
—	161	Speed setting/key lock operation selection	0, 1, 10, 11	1	0	256	
—	168	Parameter for manufacturer setting. Do not set.					
—	169						
Cumulative monitor clear	170	Watt-hour meter clear	0, 10, 9999	1	9999	155	
	171	Operation hour meter clear	0,9999	1	9999	155	
Input terminal function assignment	178	STF terminal function selection	0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 30, 44, 60, 62, 65 to 67, 76, 86 to 89, 9999	1	60	138	
	179	STR terminal function selection	0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 30, 44, 61 62, 65 to 67, 76, 86 to 89, 9999	1	61	138	
	180	RL terminal function selection	0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 30, 44, 62, 65 to 67, 76, 86 to 89, 9999	1	0	138	
	181	RM terminal function selection		1	1	138	
	182	RH terminal function selection		1	2	138	
	183	MRS terminal function selection		1	24	138	
	184	RES terminal function selection		1	62	138	
Output terminal function assignment	190	RUN terminal function selection	0, 1, 3, 4, 7, 8, 11 to 16, 21, 24 to 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 68, 90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124 to 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 168, 190, 191, 193, 195, 196, 198, 199, 9999	1	0	144	
	191	FU terminal function selection		1	4	144	
	192	ABC terminal function selection	0, 1, 3, 4, 7, 8, 11 to 16, 21, 24 to 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 68, 90, 91, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124 to 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 168, 190, 191, 195, 196, 198, 199, 9999	1	99	144	
Multi-speed setting	232	Multi-speed setting (speed 8)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	233	Multi-speed setting (speed 9)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	234	Multi-speed setting (speed 10)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	235	Multi-speed setting (speed 11)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	236	Multi-speed setting (speed 12)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	237	Multi-speed setting (speed 13)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	238	Multi-speed setting (speed 14)	0 to 4800r/min *1, 9999	1r/min	9999	117	
	239	Multi-speed setting (speed 15)	0 to 4800r/min *1, 9999	1r/min	9999	117	
—	241	Analog input display unit switchover	0, 1	1	0	173	
—	244	Cooling fan operation selection	0, 1	1	1	245	
—	249	Earth (ground) fault detection at start	0, 1	1	0	166	
—	250	Stop selection	0 to 100s, 1000 to 1100s, 8888, 9999	0.1s	9999	137, 142	
—	251	Output phase loss protection selection	0, 1	1	1	166	

Parameter list

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
149		31	B1	1	○	○	○	○	○	○
150		32	B2	1	○	○	○	○	○	○
151		33	B3	1	○	○	○	○	○	○
152		34	B4	1	○	○	○	○	○	○
153		35	B5	1	○	○	○	○	○	○
156		38	B8	1	○	○	○	○	○	○
157		39	B9	1	○	○	○	○	○	○
◎ 160		00	80	2	○	○	○	○	○	○
161		01	81	2	○	○	○	○	×	○
168	Parameter for manufacturer setting. Do not set.									
169										
170		0A	8A	2	○	○	○	○	×	○
171		0B	8B	2	○	○	○	×	×	×
178		12	92	2	○	○	○	○	×	○
179		13	93	2	○	○	○	○	×	○
180		14	94	2	○	○	○	○	×	○
181		15	95	2	○	○	○	○	×	○
182		16	96	2	○	○	○	○	×	○
183		17	97	2	○	○	○	○	×	○
184		18	98	2	○	○	○	○	×	○
190	Ver.UP	1E	9E	2	○	○	○	○	×	○
191	Ver.UP	1F	9F	2	○	○	○	○	×	○
192	Ver.UP	20	A0	2	○	○	○	○	×	○
232		28	A8	2	○	○	×	○	○	○
233		29	A9	2	○	○	×	○	○	○
234		2A	AA	2	○	○	×	○	○	○
235		2B	AB	2	○	○	×	○	○	○
236		2C	AC	2	○	○	×	○	○	○
237		2D	AD	2	○	○	×	○	○	○
238		2E	AE	2	○	○	×	○	○	○
239		2F	AF	2	○	○	×	○	○	○
241		31	B1	2	○	○	○	○	○	○
244		34	B4	2	○	○	○	○	○	○
249		39	B9	2	○	○	○	○	○	○
250		3A	BA	2	○	○	○	○	○	○
251		3B	BB	2	○	○	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Life diagnosis	255	Life alarm status display	(0 to 15)	1	0	245	
	256	Inrush current limit circuit life display	(0 to 100%)	1%	100%	245	
	257	Control circuit capacitor life display	(0 to 100%)	1%	100%	245	
	258	Main circuit capacitor life display	(0 to 100%)	1%	100%	245	
	259	Main circuit capacitor life measuring	0,1 (2, 3, 8, 9)	1	0	245	
—	267	Terminal 4 input selection	0, 1, 2	1	0	168	
—	268	Monitor decimal digits selection	0, 1, 9999	1	9999	155	
—	269	Parameter for manufacturer setting. Do not set.					
—	285	Excessive speed deviation detectiond speed	0 to 360r/min, 9999	1r/min	9999	84	
—	295	Magnitude of speed change setting	0, 0.01, 0.1, 1, 10	0.01	0	259	
Password function	296	Password lock level	0 to 6, 100 to 106, 9999	1	9999	183	
	297	Password lock/unlock	(0 to 5), 1000 to 9998, 9999	1	9999	183	
Digital input	313	DO0 output selection	0, 1, 3, 4, 7, 8, 11 to 16, 21, 24, 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64,90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124, 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 190, 191, 193, 195, 196, 198, 199, 9999	1	9999	—	
	314	DO1 output selection		1	9999	—	
	315	DO2 output selection		1	9999	—	
RS-485 communication	338	Communication operation command source	0, 1	1	0	195	
	339	Communication speed command source	0, 1, 2	1	0	195	
	340 *11	Communication startup mode selection	0, 1, 10	1	0	194	
	342	Communication EEPROM write selection	0, 1	1	0	208	
	343	Communication error count	—	1	0	222	
—	349	Communication reset selection	0,1	1	0	—	
—	374	Overspeed detection level	0 to 4800r/min *1	1r/min	3450r/min	167	
—	375	Faulty acceleration rate detection level	0 to 4800r/min *1, 9999	1r/min/ms	9999	125	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
255		3F	BF	2	○	○	○	×	×	×
256		40	C0	2	○	○	○	×	×	×
257		41	C1	2	○	○	○	×	×	×
258		42	C2	2	○	○	○	×	×	×
259		43	C3	2	○	○	○	○	○	○
267		4B	CB	2	○	○	○	○	×	○
268		4C	CC	2	○	○	○	○	○	○
269	Parameter for manufacturer setting. Do not set.									
285		5D	DD	2	○	○	×	○	○	○
295		67	E7	2	○	○	○	○	○	○
296		68	E8	2	○	○	○	○	×	○
297		69	E9	2	○	○	○	○	× *14	○
313	NC	0D	8D	3	○	○	○	○	○	○
314	NC	0E	8E	3	○	○	○	○	○	○
315	NC	0F	8F	3	○	○	○	○	○	○
338		26	A6	3	○	○	○	○	○ *13	○ *13
339		27	A7	3	○	○	○	○	○ *13	○ *13
340		28	A8	3	○	○	○	○	○ *13	○ *13
342		2A	AA	3	○	○	○	○	○	○
343		2B	AB	3	○	○	○	×	×	×
349	NC	31	B1	3	○	○	○	○	○	○
374		4A	CA	3	○	○	○	○	○	○
375		4B	CB	3	○	○	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Position control	420	Command pulse multiplication numerator (electronic gear numerator)	1 to 32767	1	1	108	
	421	Command pulse multiplication denominator (electronic gear denominator)	1 to 32767	1	1	108	
	422	Position control gain	0 to 150sec^{-1}	1sec^{-1}	20sec^{-1}	92	
	423	Position feed forward gain	0 to 100%	1%	0%	92	
	426	In-position width	0 to 32767 pulse	1 pulse	100 pulses	109	
	427	Excessive level error	0 to 400K pulse	1K pulse	40K pulses	92	
	430	Pulse monitor selection	4, 5, 100 to 105, 9999	1	9999	155	
	446	Model position control gain	0 to 150sec^{-1}	1sec^{-1}	0sec^{-1}	92	
	453	High speed during home position return	0 to 4800r/min *1	1r/min	300r/min	104	
	455	Home position return shifting speed	0 to 4800r/min *1	1r/min	1500r/min	104	
	463	Position control rotation direction selection	0,1	1	0	92	
	464	Digital position control sudden stop deceleration time	0.01 to 360s	0.01s	0.01s	100	
	465	First target position lower 4 digits	0 to 9999	1	0	95	
	466	First target position upper 4 digits	0 to 9999	1	0	95	
	467	Second target position lower 4 digits	0 to 9999	1	0	95	
	468	Second target position upper 4 digits	0 to 9999	1	0	95	
	469	Third target position lower 4 digits	0 to 9999	1	0	95	
	470	Third target position upper 4 digits	0 to 9999	1	0	95	
	471	Fourth target position lower 4 digits	0 to 9999	1	0	95	
	472	Fourth target position upper 4 digits	0 to 9999	1	0	95	
	473	Fifth target position lower 4 digits	0 to 9999	1	0	95	
	474	Fifth target position upper 4 digits	0 to 9999	1	0	95	
	475	Sixth target position lower 4 digits	0 to 9999	1	0	95	
	476	Sixth target position upper 4 digits	0 to 9999	1	0	95	
	477	Seventh target position lower 4 digits	0 to 9999	1	0	95	
	478	Seventh target position upper 4 digits	0 to 9999	1	0	95	
Remote output	495	Remote output selection	0, 1, 10, 11	1	0	152	
	496	Remote output data 1	0 to 4095	1	0	152	
Communication error	500	Communication error execution waiting time	0 to 999.8s	0.1s	0s	—	
	501	Communication error occurrence count display	0	1	0	—	
	502	Stop mode selection at communication error	0, 1, 2, 3	1	0	205, 222	
Maintenance	503	Maintenance timer	0 (1 to 9998)	1	0	248	
	504	Maintenance timer alarm output set time	0 to 9998, 9999	1	9999	248	
—	505 *15	Parameter for manufacturer setting. Do not set.					
Positioning adjustment	506	Position detection hysteresis width	0 to 32767	1	0	109	
	507	Rough match output range	0 to 32767	1	0	109	
Home position return	508	Home position shift amount lower 4 digits	0 to 9999	1	0	95, 104	
	509	Home position shift amount upper 4 digits	0 to 9999	1	0	95, 104	
Positioning adjustment	510	Position detection lower 4 digits	0 to 9999	1	0	109	
	511	Position detection upper 4 digits	0 to 9999	1	0	109	

Parameter list

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
420		14	94	4	×	×	○	○	○	○
421		15	95	4	×	×	○	○	○	○
422		16	96	4	×	×	○	○	○	○
423		17	97	4	×	×	○	○	○	○
426		1A	9A	4	×	×	○	○	○	○
427		1B	9B	4	×	×	○	○	○	○
430		1E	9E	4	×	×	○	○	○	○
446		1F	9F	4	×	×	○	○	○	○
453		35	B5	4	×	×	○	○	○	○
455		37	B7	4	×	×	○	○	○	○
463		3F	BF	4	×	×	○	○	○	○
464		40	C0	4	×	×	○	○	○	○
465		41	C1	4	×	×	○	○	○	○
466		42	C2	4	×	×	○	○	○	○
467		43	C3	4	×	×	○	○	○	○
468		44	C4	4	×	×	○	○	○	○
469		45	C5	4	×	×	○	○	○	○
470		46	C6	4	×	×	○	○	○	○
471		47	C7	4	×	×	○	○	○	○
472		48	C8	4	×	×	○	○	○	○
473		49	C9	4	×	×	○	○	○	○
474		4A	CA	4	×	×	○	○	○	○
475		4B	CB	4	×	×	○	○	○	○
476		4C	CC	4	×	×	○	○	○	○
477		4D	CD	4	×	×	○	○	○	○
478		4E	CE	4	×	×	○	○	○	○
495		5F	DF	4	○	○	○	○	○	○
496		60	E0	4	○	○	○	×	×	×
500	NC	00	80	5	○	○	○	○	○	○
501	NC	01	81	5	○	○	○	×	○	○
502		02	82	5	○	○	○	○	○	○
503		03	83	5	○	○	○	×	×	×
504		04	84	5	○	○	○	○	×	○
505	Parameter for manufacturer setting. Do not set.									
506		06	86	5	×	×	○	○	○	○
507		07	87	5	×	×	○	○	○	○
508		08	88	5	×	×	○	○	○	○
509		09	89	5	×	×	○	○	○	○
510		0A	8A	5	×	×	○	○	○	○
511		0B	8B	5	×	×	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Stopper control	512	Stopper control function selection	0, 1, 10, 11, 12	1	0	102	
	513	Stopper control torque limit	0 to 200%	1%	40%	102	
	514	Stopper control switchover position lower 4 digits	0 to 9999	1	0	102	
	515	Stopper control switchover position upper 4 digits	0 to 9999	1	0	102	
Position control	525	First positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	526	Second positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	527	Third positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	528	Fourth positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	529	Fifth positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	530	Sixth positioning sub-function	0, 1, 10, 11, 100, 101, 110, 111	1	10	95	
	531	Seventh positioning sub-function	0, 10, 100, 110	1	10	95	
	532	Home position return selection	2, 3, 4, 6	1	4	104	
	533	Home position return stopper torque	0 to 200%	0.1%	40%	104	
	534	Home position return stopper duration	0 to 10s	0.1s	0.5s	104	
	535	Position control terminal input selection	0, 1, 10, 11, 100, 101, 110, 111	1	0	100	
	536	Position detection selection	0, 1, 2	1	0	109	
	537	Roll feed mode selection	0, 1	1	0	95	
CC-Link	541	Frequency command sign selection (CC-Link)	0, 1	1	0	—	
	542	Communication station number (CC-Link)	1 to 64	1	1	—	
	543	Baud rate selection (CC-Link)	0 to 4	1	0	—	
	544	CC-Link extended setting	0, 1, 12, 14, 18	1	0	—	
USB	547 *11	USB communication station number	0 to 31	1	0	—	
	548 *11	USB communication check time interval	0 to 999.8s, 9999	0.1s	9999	—	
Communication	549 *11	Protocol selection	0, 1	1	0	204, 222	
	550 *11	NET mode operation command source selection	0, 2, 9999	1	9999	195	
	551 *11	PU mode operation command source selection	2 to 4, 9999	1	9999	195	
Current average time monitor	555	Current average time	0.1 to 1.0s	0.1s	1s	249	
	556	Data output mask time	0 to 20s	0.1s	0s	249	
	557	Current average value monitor signal output reference current	0 to 500A	0.01A	Rated motor current *9	249	
—	563	Energization time carrying-over times	(0 to 65535)	1	0	155	
—	564	Operating time carrying-over times	(0 to 65535)	1	0	155	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
512		0C	8C	5	×	○	○	○	○	○
513		0D	8D	5	×	○	○	○	○	○
514		0E	8E	5	×	×	○	○	○	○
515		0F	8F	5	×	×	○	○	○	○
525		19	99	5	×	×	○	○	○	○
526		1A	9A	5	×	×	○	○	○	○
527		1B	9B	5	×	×	○	○	○	○
528		1C	9C	5	×	×	○	○	○	○
529		1D	9D	5	×	×	○	○	○	○
530		1E	9E	5	×	×	○	○	○	○
531		1F	9F	5	×	×	○	○	○	○
532		20	A0	5	×	×	○	○	○	○
533		21	A1	5	×	×	○	○	○	○
534		22	A2	5	×	×	○	○	○	○
535		23	A3	5	×	×	○	○	○	○
536		24	A4	5	×	×	○	○	○	○
537		25	A5	5	×	×	○	○	○	○
541	NC	29	A9	5	○	○	×	○	○	○
542	NC	2A	AA	5	○	○	○	○	○	○
543	NC	2B	AB	5	○	○	○	○	○	○
544	NC	2C	AC	5	○	○	○	○	○	○
547		2F	AF	5	○	○	○	○	○ *13	○ *13
548		30	B0	5	○	○	○	○	○ *13	○ *13
549		31	B1	5	○	○	○	○	○ *13	○ *13
550		32	B2	5	○	○	○	○	○ *13	○ *13
551		33	B3	5	○	○	○	○	○ *13	○ *13
555		37	B7	5	○	○	○	○	○	○
556		38	B8	5	○	○	○	○	○	○
557		39	B9	5	○	○	○	○	○	○
563		3F	BF	5	○	○	○	×	×	×
564		40	C0	5	○	○	○	×	×	×

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Position control	578	First positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	579	First positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	580	Second positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	581	Second positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	582	Third positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	583	Third positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	584	Fourth positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	585	Fourth positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	586	Fifth positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	587	Fifth positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	588	Sixth positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	589	Sixth positioning deceleration time	0.01 to 360s	0.01s	5s	95	
	590	Seventh positioning acceleration time	0.01 to 360s	0.01s	5s	95	
	591	Seventh positioning deceleration time	0.01 to 360s	0.01s	5s	95	
—	658	Wiring resistance	0 to 5Ω, 9999	0.001Ω	9999	87	
—	665	Regeneration avoidance speed gain	0 to 200%	0.1%	100%	242	
Adjustment functions	698	Speed control D gain	0 to 100%	0.1%	0%	92	
	730	Speed estimation P gain	0 to 300%, 9999	1%	9999	86	
—	736	Electromagnetic brake interlock time	0 to 1s	0.01s	0s	135	
—	785	PM control torque boost	0 to 150%, 9999	0.1%	9999	114	
Acceleration/ deceleration time	791	Acceleration time in low-speed range	0 to 360s, 9999	0.01s	9999	125	
	792	Deceleration time in low-speed range	0 to 360s, 9999	0.01s	9999	125	
—	795	DC brake torque boost	0 to 150%, 9999	0.1%	9999	131	
—	800	Control method selection	9, 10, 13	1	10	75	
—	802	Pre-excitation selection (brake operation selection)	0, 1	1	0	131	
Adjustment functions	820	Speed control P gain	0 to 1000%	1%	100/15%*2	80	
	821	Speed control integral time	0 to 20s	0.001s	0.2/0.333s *2	80	
	824	Torque control P gain	0 to 200%, 9999	1%	9999	86	
	825	Torque control integral time	0 to 50ms, 9999	0.1ms	9999	86	
—	828	Model speed control gain	0 to 1000%	1%	60%	83	
—	853	Speed deviation time	0 to 100s	0.1s	1s	84	
Additional function	862	Notch filter time constant	0,10 to 625Hz	1Hz	0	85	
	863	Notch filter depth	0 to 3	1	0	85	
—	870	Speed detection hysteresis	0 to 180r/min	1r/min	15r/min	149	
—	871	Notch filter width	0 to 3	1	0	85	
Protective functions	872	Input phase loss protection selection	0, 1	1	0	166	
Control system function	877	Feed forward control/model adaptive control selection	0 to 2	1	0	83, 92	
	878	Speed feed forward filter	0 to 1s	0.01s	0s	83	
	879	Speed feed forward torque limit	0 to 400%	0.1%	150%	83	
	880	Load inertia ratio	0 to 200 times	0.1	7	83	
	881	Speed feed forward gain	0 to 1000%	1%	0%	83	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
578		4E	CE	5	×	×	○	○	○	○
579		4F	CF	5	×	×	○	○	○	○
580		50	D0	5	×	×	○	○	○	○
581		51	D1	5	×	×	○	○	○	○
582		52	D2	5	×	×	○	○	○	○
583		53	D3	5	×	×	○	○	○	○
584		54	D4	5	×	×	○	○	○	○
585		55	D5	5	×	×	○	○	○	○
586		56	D6	5	×	×	○	○	○	○
587		57	D7	5	×	×	○	○	○	○
588		58	D8	5	×	×	○	○	○	○
589		59	D9	5	×	×	○	○	○	○
590		5A	DA	5	×	×	○	○	○	○
591		5B	DB	5	×	×	○	○	○	○
658	Ver.UP	3A	BA	6	○	○	○	○	○	○
665		41	C1	6	○	○	×	○	○	○
698		62	E2	6	×	○	○	○	○	○
730		1E	9E	7	○	○	○	○	○	○
736		24	A4	7	○	○	○	○	○	○
785	Ver.UP	55	D5	7	○	×	×	○	○	○
791		5B	DB	7	○	○	×	○	○	○
792		5C	DC	7	○	○	×	○	○	○
795	Ver.UP	5F	DF	7	○	×	×	○	○	○
800		00	80	8	○	○	○	○	○	○
802		02	82	8	×	○	×	○	○	○
820		14	94	8	○	○	○	○	○	○
821		15	95	8	○	○	○	○	○	○
824		18	98	8	○	○	○	○	○	○
825		19	99	8	○	○	○	○	○	○
828		1C	9C	8	×	○	○	×	×	×
853		35	B5	8	○	○	×	○	○	○
862		3E	BE	8	○	○	○	○	○	○
863		3F	BF	8	○	○	○	○	○	○
870		46	C6	8	○	○	○	○	○	○
871		47	C7	8	○	○	○	○	○	○
872		48	C8	8	○	○	○	○	○	○
877		4D	CD	8	×	○	○	○	○	○
878		4E	CE	8	×	○	○	○	○	○
879		4F	CF	8	×	○	○	○	○	○
880		50	D0	8	×	○	○	○	○	○
881		51	D1	8	×	○	○	○	○	○

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Regeneration avoidance function	882	Regeneration avoidance operation selection	0, 1, 2	1	0	242	
	883	Regeneration avoidance operation level	300 to 800V	0.1V	400VDC	242	
	885	Regeneration avoidance compensation speed limit value	0 to 540r/min *6, 9999	1r/min	180r/min	242	
	886	Regeneration avoidance voltage gain	0 to 200%	0.1%	100%	242	
Free parameter	888	Free parameter 1	0 to 9999	1	9999	251	
	889	Free parameter 2	0 to 9999	1	9999	251	
Calibration parameters	C0 (900) *10	FM terminal calibration	—	—	—	162	
	C2 (902) *10	Terminal 2 speed setting bias speed	0 to 4800r/min	1r/min	0r/min	173	
	C3 (902) *10	Terminal 2 speed setting bias	0 to 300%	0.1%	0%	173	
	125 (903) *10	Terminal 2 speed setting gain speed	0 to 4800r/min	1r/min	3000r/min	173	
	C4 (903) *10	Terminal 2 speed setting gain	0 to 300%	0.1%	100%	173	
	C5 (904) *10	Terminal 4 speed setting bias speed	0 to 4800r/min	1r/min	0r/min	173	
	C6 (904) *10	Terminal 4 speed setting bias	0 to 300%	0.1%	20%	173	
	126 (905) *10	Terminal 4 speed setting gain speed	0 to 4800r/min	1r/min	3000r/min	173	
	C7 (905) *10	Terminal 4 speed setting gain	0 to 300%	0.1%	100%	173	
PU	990	PU buzzer control	0, 1	1	1	260	
	991	PU contrast adjustment	0 to 63	1	58	260	
—	997	Fault initiation	16 to 18, 32 to 34, 48, 49, 64, 82, 96, 97, 112, 128, 129, 144, 160, 161, 176 to 179, 192, 197, 199 to 201, 208, 209, 211, 221, 241, 245, 246, 247, 253, 9999	1	9999	252	
—	998 *15	PM parameter initialization	3024, 3124, 6004, 6104 *7	1	3024/6004 *2	73	
—	999	Automatic parameter setting	10, 9999	1	9999	253	

Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
882		52	D2	8	○	○	×	○	○	○
883		53	D3	8	○	○	×	○	○	○
885		55	D5	8	○	○	×	○	○	○
886		56	D6	8	○	○	×	○	○	○
888		58	D8	8	○	○	○	○	×	×
889		59	D9	8	○	○	○	○	×	×
C0 (900)		5C	DC	1	○	○	○	○	×	○
C2 (902)		5E	DE	1	○	○	×	○	×	○
C3 (902)		5E	DE	1	○	○	×	○	×	○
125 (903)		5F	DF	1	○	○	×	○	×	○
C4 (903)		5F	DF	1	○	○	×	○	×	○
C5 (904)		60	E0	1	○	○	×	○	×	○
C6 (904)		60	E0	1	○	○	×	○	×	○
126 (905)		61	E1	1	○	○	×	○	×	○
C7 (905)		61	E1	1	○	○	×	○	×	○
990		5A	DA	9	○	○	○	○	○	○
991		5B	DB	9	○	○	○	○	×	○
997	Ver.UP	61	E1	9	○	○	○	×	×	×
998	Ver.UP	62	E2	9	○	○	○	○	○	○
999	Ver.UP	63	E3	9	○	○	○	×	×	×

Function	Parameter	Name	Setting Range	Minimum Setting Increments	Initial Value	Refer to Page	Customer Setting
Clear parameters Initial value change list	Pr.CL	Parameter clear	0, 1	1	0	*261*	
	ALLC	All parameter clear	0, 1	1	0	*261*	
	Er.CL	Fault history clear	0, 1	1	0	*263*	
	Pr.CH	Initial value change list	—	—	—	*262*	
—	PM	PM parameter initialization	3024, 6004 *8	1	3024/6004 *2	*73*	
—	AUTO Ver.UP	Automatic parameter setting	—	—	—	*253*	

*1 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)
*2 The setting differs according to the drive unit capacity. (0.75K or lower / 1.5K or higher)
*3 The setting differs according to the drive unit capacity. (0.75K or lower / 1.5K and 2.2K / 3.7K)
*4 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 900 r/min, 3.7K: 600 r/min)
*5 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 450 r/min, 3.7K: 300 r/min)
*6 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 1350 r/min, 3.7K: 900 r/min)
*7 The setting differs according to the drive unit capacity. (0.1K: 3024, 3124 / 0.2K to 0.75K: 3024, 3124, 6004, 6104 / 1.5K to 3.7K: 6004, 6104)
*8 The setting differs according to the drive unit capacity. (0.1K: 3024 / 0.2K to 0.75K: 3024, 6004 / 1.5K to 3.7K: 6004)
*9 The setting differs according to the drive unit capacity. (0.75K or lower: rated current of MM-GKR motor *(Refer to page 307.)*, 1.5K or higher: rated current of S-PM geared motor *(Refer to page 310.)*)
*10 The parameter number in parentheses is the one for use with the parameter unit (FR-PU07).
*11 The setting is applied after a drive unit reset or power-ON.
*12 Write is disabled in the communication mode (Network operation mode) from the PU connector.
*13 These parameters are communication parameters that are not cleared when parameter clear (all clear) is executed from RS-485 communication. (*Refer to page 204* for RS-485 communication).
*14 When a communication option is installed, parameter clear (lock release) during password lock (*Pr.297* ≠ 9999) can be performed only from the communication option.
*15 A verification error may occur during parameter verification of the parameters copied using the parameter unit (FR-PU07). A verification error on the manufacturer setting parameters will not affect the operation. Press the "0" key on the parameter unit and proceed with the operation. (Refer to the Instruction Manual of the parameter unit.)

REMARKS

- The unit for parameter setting and its setting range can be changed from "r/min" to "Hz". Use *Pr.144* to change the setting.
- With operation panel, the value up to 9999 can be set. With parameter unit (FR-PU07) or FR Configurator, up to the highest value in the setting range can be set.
- A value exceeding 3000r/min can be also set, but the actual operation will be limited at 3000r/min, which is the upper speed limit of the motor.

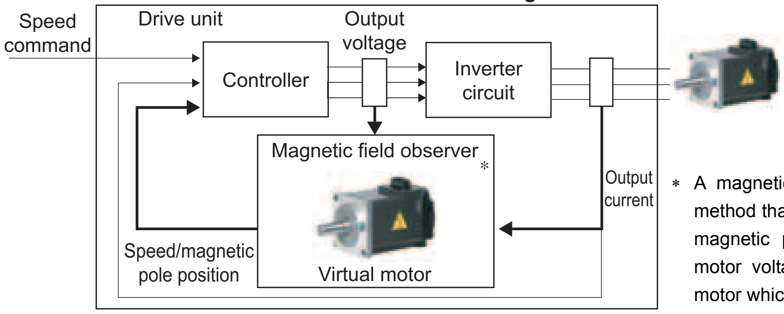
Parameter	Remarks	Instruction Code			Motor/Control Mode Support Table			Parameter		
					S-PM	MM-GKR				
		Read	Write	Extended	Speed	Speed	position	Copy	Clear	All clear
Pr.CL		—	FC	—	—	—	—	—	—	—
ALLC		—	FC	—	—	—	—	—	—	—
Er.CL		—	F4	—	—	—	—	—	—	—
Pr.CH		—	—	—	—	—	—	—	—	—
PM	Ver.UP	—	—	—	—	—	—	—	—	—
AUTO	Ver.UP	—	—	—	—	—	—	—	—	—

4.3 PM sensorless vector control

4.3.1 Outline of PM sensorless vector control

A dedicated PM (magnet) motor is a highly efficient motor compared to an induction motor. With this PM motor, highly efficient motor control and highly accurate motor speed control can be performed.
Without using a speed detector such as an encoder, the motor speed is detected based on the output voltage and current of the drive unit, and highly accurate speed control and position control can be performed.

PM sensorless vector control image



* A magnetic field observer is a control method that calculates the motor speed/ magnetic pole position based on the motor voltage and current of a virtual motor which is set up in the drive unit.

POINT

- The following conditions must be met to perform PM sensorless vector control.
  - For the motor model, dedicated PM motor must be used.
  - A specified combination of the motor capacity and the drive unit capacity must be used.
  - Single-motor operation (one motor run by one drive unit) must be performed.
  - The overall wiring length with the motor must be 30m or less.

NOTE

- **In the low-speed range (about 100 r/min or lower), rotation ripple occurs due to cogging torque of the motor.**
- **The RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the magnetic pole detection.**

4.3.2 Automatic parameter setting in accordance with the motor (Pr.998)

- Performing PM parameter initialization automatically adjusts the parameter initial settings and setting ranges required to drive the PM motor being used.
- Initialization is performed by setting *Pr.998 PM parameter initialization* or by choosing the mode on the operation panel.

Parameter number	Name	Initial value	Setting range	Operation
998 Ver.UP	**PM parameter initialization**	3024/ 6004 *1	3024 *2	Parameter settings for an MM-GKR motor (rotations per minute)
			3124 *2	Parameter settings for an MM-GKR motor (frequency)
			6004 *3	Parameter settings for an S-PM geared motor (rotations per minute)
			6104 *3	Parameter settings for an S-PM geared motor (frequency)

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
*1 The setting differs according to the drive unit capacity. (0.75K or lower / 1.5K or higher)
*2 The setting is available only with the 0.1K to 0.75K class.
*3 The setting is available only with the 0.2K to 3.7K class.
Ver.UP ....Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

(1) PM parameter initialization *(Pr.998)*

- When *Pr.998* ="3024 or 6004", the monitor is displayed and the speed is set using the motor rotations per minute.

To use frequency to display or set, set *Pr.998* ="3124 or 6104".

Pr.998 setting	Description	Operation after selecting the parameter setting mode on the operation panel
3024	Parameter settings for an MM-GKR motor (rotations per minute)	PM (PM) → write "3024"
3124	Parameter settings for an MM-GKR motor (frequency)	Not available
6004	Parameter settings for an S-PM geared motor (rotations per minute)	PM (PM) → write "6004"
6104	Parameter settings for an S-PM geared motor (frequency)	Not available

4

PARAMETERS

REMARKS

- Make sure to set *Pr.998* before setting other parameters. If the *Pr.998* setting is changed after setting other parameters, some of those parameters will be initialized too. (Refer to "(2) PM parameter initialization list" for the parameters that are initialized.)
- If the setting of *Pr.998 PM parameter initialization* is changed from "3024, 6004 (rotations per minute)" to "3124, 6104 (frequency)", or from "3124, 6104" to "3024, 6004", all the target parameters are initialized.
  The purpose of *Pr.998* is not to change the display units. Use *Pr.144 Speed setting switchover* to change the display units between rotations per minute and frequency. *Pr.144* enables switching of display units between rotations per minute and frequency without initializing the parameter settings.
  Example) Changing the *Pr.144* setting between "6" and "106" switches the display units between frequency and rotations per minute.

(2) PM parameter initialization list

The parameter settings in the following table are changed to the settings required to perform control for the applied PM motor with the parameter setting mode or with *Pr.998 PM parameter initialization* setting. The changed settings differ according to the applied PM motor. For the settings, refer to the PM motor specifications table below.

Parameter number	Name	Setting value		Setting increments	
		PM motor (rotations per minute)	PM motor (frequency)		
	Pr.998	3024 (MM-GKR), 6004 (S-PM)	3124 (MM-GKR), 6104 (S-PM)	3024, 6004	3124, 6104
1	Maximum setting	Maximum motor rotation speed	Maximum motor frequency	1r/min	0.01Hz
4	Multi-speed setting (high speed)	Rated motor rotation speed	Rated motor frequency	1r/min	0.01Hz
5	Multi-speed setting (middle speed)	50% of the rated motor rotation speed	50% of the rated motor frequency	1r/min	0.01Hz
6	Multi-speed setting (low speed)	10% of the rated motor rotation speed	10% of the rated motor frequency	1r/min	0.01Hz
9	Electronic thermal O/L relay	Rated motor current		0.01A	
10	Coasting speed	3% of the rated motor rotation speed	3% of the rated motor frequency	1r/min	0.01Hz
13	Starting speed	0.5% of the rated motor rotation speed	0.5% of the rated motor frequency	1r/min	0.01Hz
15	Jog speed setting	5% of the rated motor rotation speed	5% of the rated motor frequency	1r/min	0.01Hz
20	Acceleration/deceleration reference speed	Rated motor rotation speed	Rated motor frequency	1r/min	0.01Hz
22	Torque limit level	MM-GKR: 200%, S-PM: 150%		0.1%	
37	Speed display	0		1	
42	Speed detection	6% of the rated motor rotation speed	6% of the rated motor frequency	1r/min	0.01Hz
55	Speed monitoring reference	Rated motor rotation speed	Rated motor frequency	1r/min	0.01Hz
56	Current monitoring reference	Rated motor current		0.01A	
125(903)	Terminal 2 speed setting gain speed	Rated motor rotation speed	Rated motor frequency	1r/min	0.01Hz
126(905)	Terminal 4 speed setting gain speed	Rated motor rotation speed	Rated motor frequency	1r/min	0.01Hz
144	Speed setting switchover	Number of motor poles + 100	Number of motor poles	1	
374	Overspeed detection level	Rated motor rotation speed × 1.15	Rated motor frequency × 1.15	1r/min	0.01Hz
453	High speed during home position return	10% of the rated motor rotation speed	10% of the rated motor frequency	1r/min	0.01Hz
455	Home position return shifting speed	50% of the rated motor rotation speed	50% of the rated motor frequency	1r/min	0.01Hz
557	Current average value monitor signal output reference current	Rated motor current		0.01A	
730	Speed estimation P gain	9999		1%	
820	Speed control P gain	MM-GKR: 100%, S-PM: 15%		1%	
821	Speed control integral time	MM-GKR: 0.200s, S-PM: 0.333s		0.001s	
824	Torque control P gain	9999		1%	
825	Torque control integral time	9999		0.1ms	
870	Speed detection hysteresis	0.5% of the rated motor rotation speed	0.5% of the rated motor frequency	1r/min	0.01Hz
885	Regeneration avoidance compensation speed limit value	6% of the rated motor rotation speed	6% of the rated motor frequency	1r/min	0.01Hz

REMARKS

- If PM motor control parameter initialization is performed in frequency (*Pr.998* = "3124 or 6104"), the rotation speed parameters not listed in the table and the monitored items are also set and displayed in frequency.

<PM motor specifications table>

	MM-GKR (0.1kW to 0.75kW)	S-PM (0.1kW to 1.5kW)	S-PM (2.2kW)
Rated motor rotation speed (frequency)	3000r/min (250Hz)	3000r/min (100Hz)	3000r/min (150Hz)
Maximum motor rotation speed (frequency)	3000r/min (250Hz)	3000r/min (100Hz)	3000r/min (150Hz)
Number of motor poles	10	4	6

⚠ CAUTION

⚠ **According to the motor to be connected, perform PM parameter initialization. Incorrect initial setting of parameters may damage the motor.**
In the initial setting, FR-E720EX-0.1K to 0.75K is set for an MM-GKR motor, and FR-E720EX-1.5K to 3.7K is set for an S-PM geared motor.
Only use a motor that is a dedicated PM motor (MM-GKR motor or S-PM geared motor).

4.3.3 Changing the control method (Pr.800)

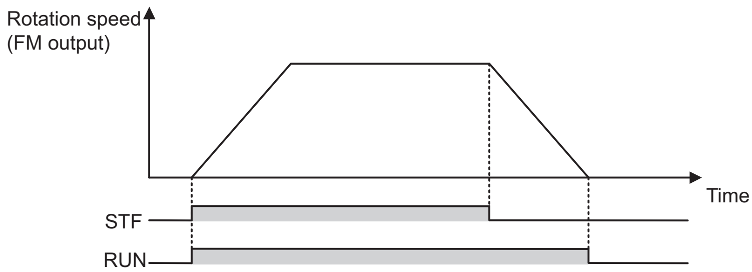
- Select the control method between speed control and position control.
  Under speed control, the motor is controlled so that its rotation speed (estimated speed) and the speed command match.
  Under position control, a speed command is calculated to eliminate the difference between position command and estimated position and output to rotate the motor.

Parameter number	Name	Initial value	Setting range	Operation
800	Control method selection	10	9	PM motor test operation (Speed control) (Motor is not driven even if it is connected.)
			10	Normal operation (Speed control) *(Refer to page 79)*
			13	Normal operation (Position control) *(Refer to page 91)* *

The above parameter can be set when *Pr.160 Extended function display selection* ="0". *(Refer to page 182)*
* When an S-PM geared motor is used (*Pr.998*="6004 or 6104"), the operation is performed under speed control.

(1) PM motor test operation (*Pr.800* ="9")

- Without connecting a PM motor, the speed movement can be checked by the monitor or analog signal output.
- Two types of operation can be selected using this parameter: an actual operation by connecting a PM motor, or a test operation without connecting a PM motor to simulate a virtual operation.
- Setting *Pr.800 Control method selection* = "9" will enable the PM motor test operation in speed control.
  Perform a test run by giving a speed command and a start command under each of PU/External/Network operation mode.



REMARKS

- In the test operation, current is not detected and voltage is not output. Related monitor displays of the output current and voltage show "0".

(2) Valid/invalid statuses of I/O terminal functions during the test operation

Input signal			Output signal		
Signal name	Function		Signal name	Function	
RL	Low-speed operation command	○	RUN	Drive unit running	○
RM	Middle-speed operation command	○	SU	Up to speed	○
RH	High-speed operation command	○	OL	Overload alarm	×
RL	Remote setting (setting clear)	○	FU	Rotation speed detection	○
RM	Remote setting (deceleration)	○	RBP	Regenerative brake pre-alarm	○
RH	Remote setting (acceleration)	○	THP	Electronic thermal O/L relay pre-alarm	×
RT	Second function selection	○	RY	Drive unit operation ready	○
AU	Terminal 4 input selection	○	Y12	Output current detection	○
JOG	JOG operation selection	○	Y13	Zero current detection	○
OH	External thermal relay input	○	FDN	PID lower limit	○
REX	15-speed selection (combination with three speeds RL, RM, RH)	○	FUP	PID upper limit	○
X10	Drive unit run enable signal (FR-HC2/FR-CV connection)	○	RL	PID forward/reverse rotation output	○
X12	PU operation external interlock	○	MBR	Electromagnetic brake interlock	○
X14	PID control valid terminal	○	LP	Stroke limit warning	○
X16	PU/External operation switchover	○	FIN	Heatsink overheat pre-alarm	○
LX	Pre-excitation	○	RY2	Operation ready 2	○
MRS	Output stop	○	Y36	In-position	×
STOP	Start self-holding selection	○	MEND	Travel completed	×
X29	Stopper control switchover	×	PID	During PID control activated	○
JOG2	JOG operation selection 2	○	CPO	Rough match	×
X44	Selects P control (P/PI control switchover)	×	ZA	Home position return failure warning	×
STF	Forward rotation command	○	FP	Position detection	×
STR	Reverse rotation command	○	PBSY	Position command creating	×
RES	Drive unit reset	○	ZP	Home position return completed	×
X65	PU/NET operation switchover	○	Y64	During retry	○
X66	External/NET operation switchover	○	Y90	Life alarm	○
X67	Command source switchover	○	Y91	Fault output 3 (power-off signal)	○
X76	Proximity dog	×	Y93	Current average value monitor signal	○
X86	Servo ON	○	Y95	Maintenance timer signal	○
X87	Position control sudden stop	×	REM	Remote output	○
LSP	Forward stroke end	○	LF	Alarm output	○
LSN	Reverse stroke end	○	ALM	Fault output	○
9999	No function	—	9999	No function	—

○: Valid
×: Invalid

(3) Valid/invalid statuses of monitor outputs during the test operation

Monitoring items	DU/PU monitor display	FM output	Communication
Rotation speed	○	○	○
Output current	×	×	×
Output voltage	×	×	×
Fault display	○	—	○
Speed setting value	○	○	○
Converter output voltage	○	○	○
Regenerative brake duty	○	○	○
Electronic thermal relay load factor	× *1	× *1	× *1
Output current peak value	× *2	× *2	× *2
Converter output voltage peak value	○	○	○
Output power	×	×	×
Position pulse	×	×	×
Cumulative energization time	○	—	○
Reference voltage output	—	○	—
Actual operation time	○	—	○
Motor load factor	×	×	×
Cumulative power	Δ	—	Δ
Position command (upper/lower)	×	×	×
Current position (upper/lower)	×	×	×
Droop pulse (upper/lower)	×	×	×
Ideal speed command	×	×	×
Speed command	○	○	○
PID set point	○	○	○
PID measured value	○	○	○
PID deviation	○	—	○
Input terminal status	—/○	—	○
Output terminal status	—/○	—	○
Drive unit I/O terminal status	○/—	—	—
Motor thermal relay load factor	× *1	× *1	× *1
Drive unit thermal relay load factor	× *1	× *1	× *1
Cumulative power (for communication, in units of 0.01 kWh)	—	—	Δ

○ : Valid
× : Invalid (always displays 0)
Δ : Displays accumulated value before the test
— : Not monitored

*1 Monitor output is valid or invalid depending on the monitor type (operation panel display, parameter unit display, or terminal FM/ AM). For details, *refer to page 155.*

*2 When the operation is switched to the test operation, "0" is displayed. When PM sensorless vector control is selected again after a test operation, the output current peak value and the electronic thermal relay load factor from the last operation are displayed.

Parameters referred to

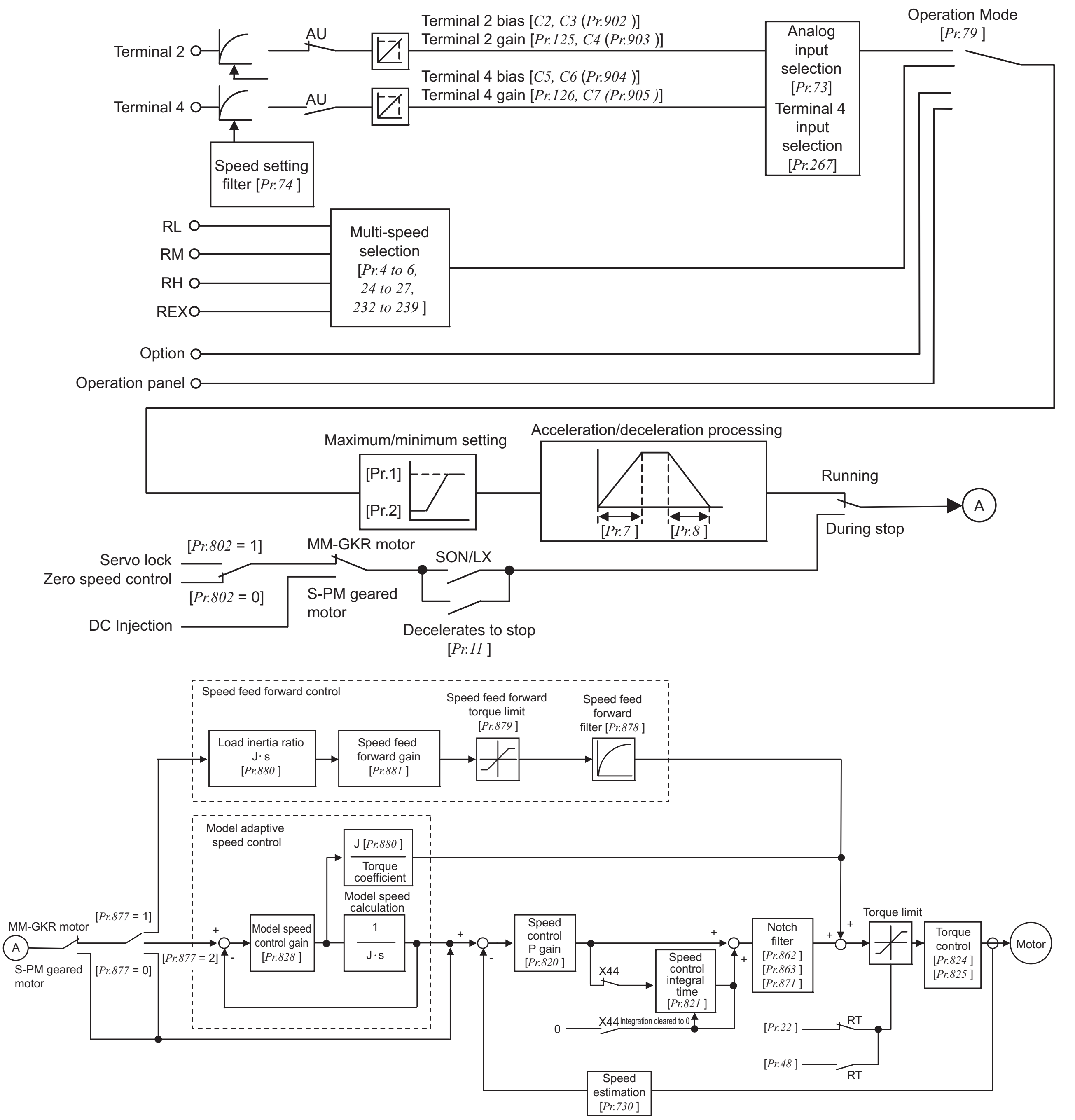
Pr.52 DU/PU main display data selection *Refer to page 155*
Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*
Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.4 Speed control

Purpose	Parameter to set		Refer to page
To adjust gain for speed control	Gain adjustment	Pr.820, Pr.821	*80*
To enhance the trackability of the motor in response to a speed command change	Speed feed forward control, model adaptive speed control	Pr.828, Pr.877 to Pr.881	*83*
To avoid mechanical resonance	Notch filter	Pr.862, Pr.863, Pr.871	*85*
To adjust gain for PM motor control	Gain adjustment	Pr.730, Pr.824, Pr.825	*86*
To improve the acceleration/ deceleration characteristics	Wiring resistance	Pr.658	*87*

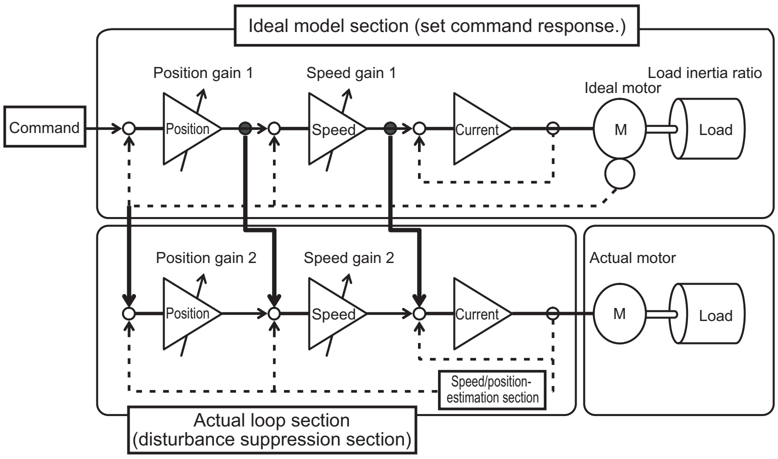
4.4.1 Outline of speed control

(1) Control block diagram



(2) Model adaptive control and feed forward control GKR

The model adaptive control is a control logic based on the load inertia setting to set gains individually for the ideal model section and the actual loop section, achieving a fast-responsing and mechanically stable setting.
The ideal model section is not affected by disturbances or backlashes of the machine. Thus, even with the fast-response setting of each gain, excellent characteristics are seen.
The actual loop section (disturbance suppression section) is designed based on PI control. If a difference is caused between the model position/speed created at the ideal model section and the actual motor position/speed due to disturbance torque, a torque command is output from the actual loop section to follow the model position/speed. To increase the suppression effect against disturbances, set higher gains. However, setting the gains too high may cause vibration.
Because the operation in the ideal model section is based on the load inertia, proper control may not be performed when the load inertia setting is different from the actual load inertia.



Under position feed forward control, a speed command necessary for tracking positions is calculated in advance and added to the control commands. Under speed feed forward control, a torque current command necessary for acceleration/deceleration is calculated in advance and added to the control commands. The response that cannot be improved by only usual gain adjustment can be improved by using feed forward control.
A load inertia setting different from the actual load inertia, or too high feed forward gain settings may cause vibrations or improper control.

4.4.2 Setting procedure of speed control

Perform secure wiring. *(Refer to page 14)*

↓

Change the parameter settings to the initial value in accordance with the applied motor. *(Pr.998) (Refer to page 73)*

"3024": Parameter settings for an MM-GKR motor (rotations per minute)
"3124": Parameter settings for an MM-GKR motor (frequency)
"6004": Parameter settings for an S-PM geared motor (rotations per minute)
"6104": Parameter settings for an S-PM geared motor (frequency)

↓

Select the control method. *(Pr.800) (Refer to page 75)*

Set *Pr.800*="10" (initial value) to enable speed control.

↓

Set parameters such as the acceleration/deceleration time and multi-speed setting.

Set parameters such as the acceleration/deceleration time and multi-speed setting as required.

↓

Set the operation command. *(Refer to page 186)*

Select the start command and speed command.

↓

Test run

As required
- Adjust the speed control gain. *(Pr.820, 821) (Refer to page 80)*

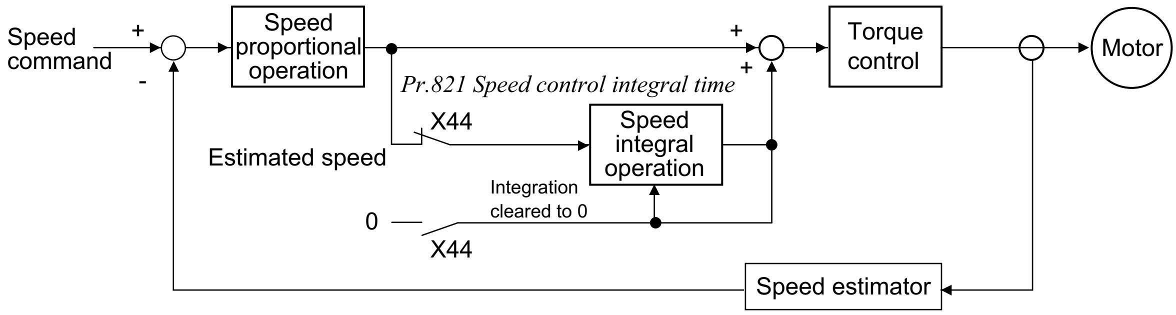
4.4.3 Adjusting the speed control gain (Pr.820, Pr.821, X44 signal)

- Manual adjustment of gain is useful to exhibit the optimum performance of the machine or to improve unfavorable conditions such as vibration and acoustic noise during the operation with high load inertia or gear backlashes.

Parameter number	Name	Initial value		Setting range	Operation
820	Speed control P gain	0.75K or lower	100%	0 to 1000%	The proportional gain during speed control is set. (Setting this parameter higher improves the trackability for speed command changes. It also reduces the speed fluctuation due to a load fluctuation.) 100% is equivalent to 200rad/s.
		1.5K or higher	15%		
821	Speed control integral time	0.75K or lower	0.2s	0 to 20s	The integral time during speed control is set. (Setting this parameter lower shortens the return time to the original speed when the speed fluctuates due to a load fluctuation.)
		1.5K or higher	0.333s		

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Control block diagram

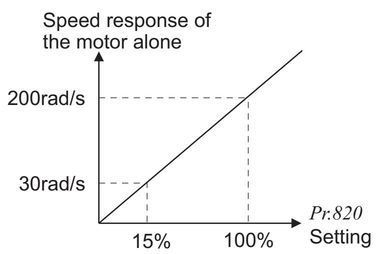


(2) P/PI switchover (X44 signal)

- By turning the P/PI control switching signal (X44) ON/OFF, you can select whether to add the integral time (I) or not when performing gain adjustment with P gain and integral time. Under position control, the X44 signal is invalid. (PI control is constantly valid.)
  When the X44 signal is OFF ....PI control
  When the X44 signal is ON ....P control
- For the terminal used for X44 signal input, set "44" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.

(3) Adjusting the speed control gain manually

- The speed control gain can be adjusted for the conditions such as abnormal machine vibration, acoustic noise, slow response, and overshoot.

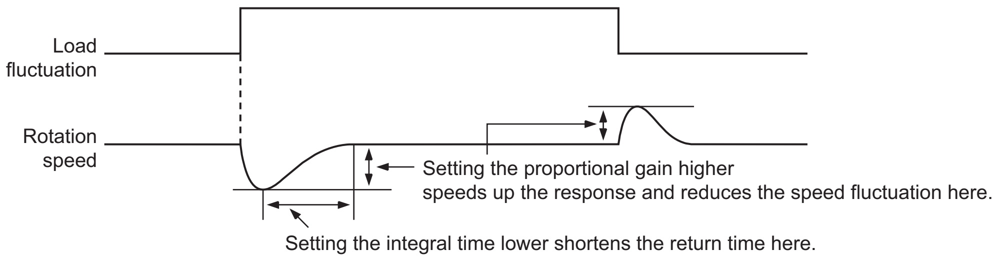


- *Pr.820 Speed control P gain* higher speeds up the response, but setting this too high causes vibration and acoustic noise.
- Setting *Pr.821 Speed control integral time* lower shortens the return time to the original speed at a speed fluctuation, but setting it too low causes overshoot.

• Actual speed response is calculated as below when load inertia is applied.

$$\text{Actual speed response} = \text{Speed response of the motor alone} \times \frac{JM}{JM+JL}$$

JM: Motor inertia
JL: Load inertia converted as the motor axis inertia



- Adjust in the following procedure:
  1) Change the *Pr.820* setting so that the actual response becomes 100 rad/s to 200 rad/s.
     (Example) When setting the actual speed response to 200 rad/s with double the load inertia

$$\text{Actual speed response} = \text{Speed response of the motor alone} \times \frac{JM}{JM+JL}$$

JM: Motor inertia
JL: Load inertia converted as the motor axis inertia

$$200\text{rad/s} = \text{Speed response of the motor alone} \times \frac{JM}{JM+2\times JM}$$

Speed response of the motor alone = 200rad/s×3 = 600rad/s → Set *Pr.820* = "300%".

  2) Set a reciprocal of 1/20 to 1/5 of the actual speed response in *Pr.821*.
     (Example 1) With the actual speed response of 200 rad/s, and with setting *Pr.821* to 1/20 of the speed response

$$Pr.821 = \frac{1}{200\text{rad/s} \times \frac{1}{20}} = 0.100\text{s}$$

  3) Check that the motor rotation speed and torque current command value are stable.
     If the motor rotation speed or torque current command is not stable, decrease the actual speed response.
     Adjust the gain following the procedure below, as required.

No.	Movement/ condition	Adjustment method	
1	Load inertia is too high.	Set *Pr.820* and *Pr.821* higher.	
		Pr.820	If acceleration is slow, raise the setting by 10%s and set a value that satisfies the following condition: The setting immediately before vibration/ noise starts occurring ×0.8 to 0.9
		Pr.821	If overshoots occur, raise the setting by double the setting and set a value that satisfies the following condition: The setting where overshoots stop occurring ×0.8 to 0.9
2	Vibration or acoustic noise is generated from machines.	Set *Pr.820* lower and *Pr.821* higher.	
		Pr.820	Lower the setting by 10%s and set a value that satisfies the following condition: The setting immediately before vibration/noise starts occurring × 0.8 to 0.9
		Pr.821	If overshoots occur, raise the setting by double the setting and set a value that satisfies the following condition: The setting where overshoots stop occurring × 0.8 to 0.9
3	Response is slow.	Set *Pr.820* higher.	
		Pr.820	If acceleration is slow, raise the setting by 5%s and set a value that satisfies the following condition: The setting immediately before vibration/noise starts occurring × 0.8 to 0.9
4	Return time (response time) is long.	Set *Pr.821* lower.	
		Lower *Pr.821* by half the current setting and set a value that satisfies the following condition: The setting immediately before overshoots or unstable movements stop occurring × 0.8 to 0.9	
5	Overshoots or unstable movements occur.	Set *Pr.821* higher.	
		Raise *Pr.821* by double the current setting and set a value that satisfies the following condition: The setting immediately before overshoots or unstable movements stop occurring × 0.8 to 0.9	

(4) Troubleshooting

	Condition	Possible cause	Countermeasure
1	Motor does not run at the correct speed. (Command speed and actual speed differ.)	(1) Speed command from the controller is different from the actual speed. The speed command is affected by noise. (2) The command speed and the speed recognized by the drive unit are different.	(1) Check that the speed command sent from the controller is correct. (Take EMC measures.) (2) Adjust bias and gain *(Pr.125, Pr.126, C2 to C4)* of the speed command again.
2	The speed does not accelerate to the command speed.	(1) Torque shortage The torque limit is activated. (2) Only P (proportion) control is performed.	(1) -1 Raise the torque lilmit level. *(Refer to page 111)* (1) -2 Capacity shortage (2) Speed deviation occurs under P (proportional) control when the load is heavy. Select PI control.
3	Motor speed fluctuates.	(1) Speed command varies. (2) Torque shortage (3) Speed control gain is not suitable for the machine. (Resonance occurs.)	(1) -1 Check that the speed command sent from the controller is correct. (Take EMC measures.) (2) Raise the torque lilmit level. *(Refer to page 111)* (3) Adjust *Pr.820* and *Pr.821 (Refer to page 80)*
4	Hunting (vibration or acoustic noise) occurs in the motor or the machine.	(1) Speed control gain is too high. (2) Motor wiring is incorrect. (3) Mechanical resonance occurs.	(1) Set *Pr.820* lower and *Pr.821* higher. (2) Check the wiring. (3) Set and adjust the notch filter *(Pr.862, Pr.863, and Pr.871)*.
5	Acceleration/deceleration time is different from the setting.	(1) Torque shortage (2) Load inertia is too high.	(1) Raise the torque lilmit level. *(Refer to page 111)* (2) Set acceleration/deceleration time suitable for the load.
6	Machine movement is unstable.	(1) Speed control gain is not suitable for the machine. (2) Response is slow because of the drive unit's acceleration/ deceleration time setting.	(1) Adjust *Pr.820* and *Pr.821 (Refer to page 80)* (2) Set the optimum acceleration/deceleration time.
7	Rotation ripple occurs during the low-speed operation.	Speed control gain is too low.	Raise *Pr.820*.

4.4.4 Speed feed forward control, model adaptive speed control (Pr.828, Pr.877 to Pr.881) GKR

By making parameter setting, select the speed feed forward control or model adaptive speed control.
The speed feed forward control enhances the trackability of the motor in response to a speed command change.
The model adaptive speed control enables individual adjustment of speed trackability and motor disturbance torque response.

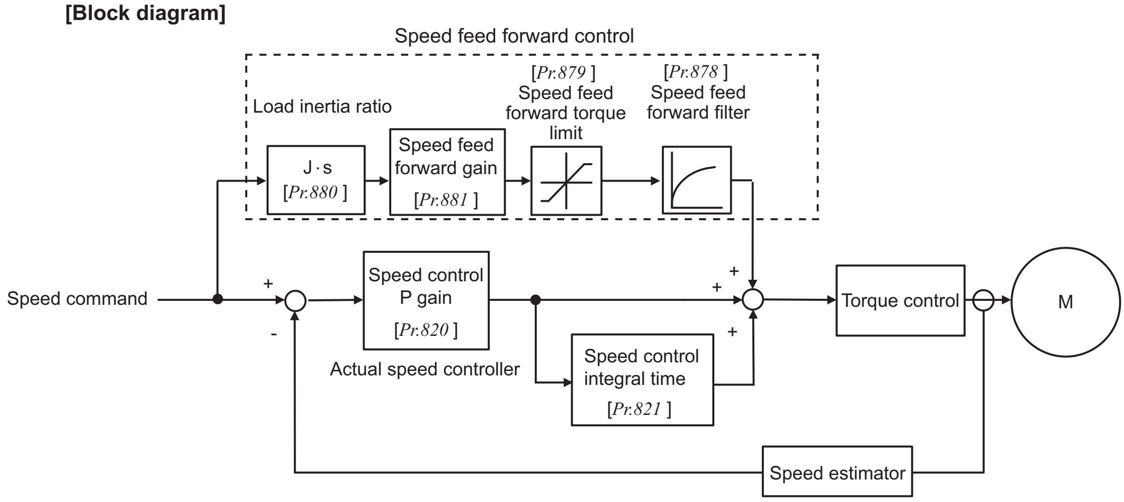
Parameter number	Name	Initial value	Setting range	Description
828	**Model speed control gain**	60%	0 to 1000%	Set the gain for model speed controller. 100% is equivalent to 100 rad/s.
877	**Feed forward control/ model adaptive control selection**	0	0	Normal speed control is exercised.
			1	Speed feed forward control is exercised.
			2	Model adaptive speed control is enabled.
878	**Speed feed forward filter**	0s	0 to 1s	Set the primary delay filter for the speed feed forward result calculated using the speed command and load inertia ratio.
879	**Speed feed forward torque limit**	150%	0 to 400%	Limits the maximum value of the speed feed forward torque.
880	**Load inertia ratio**	7 times	0 to 200 times	Set the load inertia ratio to the motor.
881	**Speed feed forward gain**	0%	0 to 1000%	Set the feed forward calculation result as a gain.

The above parameters are available only with MM-GKR motors.

(1) Speed feed forward control (*Pr.877* = "1")

- Calculate required torque in response to the acceleration/deceleration command for the inertia ratio set in *Pr.880* and generate torque immediately.
- When the speed feed forward gain is 100%, the calculation result of the speed feed forward is applied as is.
- If the speed command changes suddenly, large torque is generated due to the speed feed forward calculation. The maximum value of the speed feed forward is limited using *Pr.879*.
- Using *Pr.878*, the speed feed forward result can be dulled by the primary delay filter.

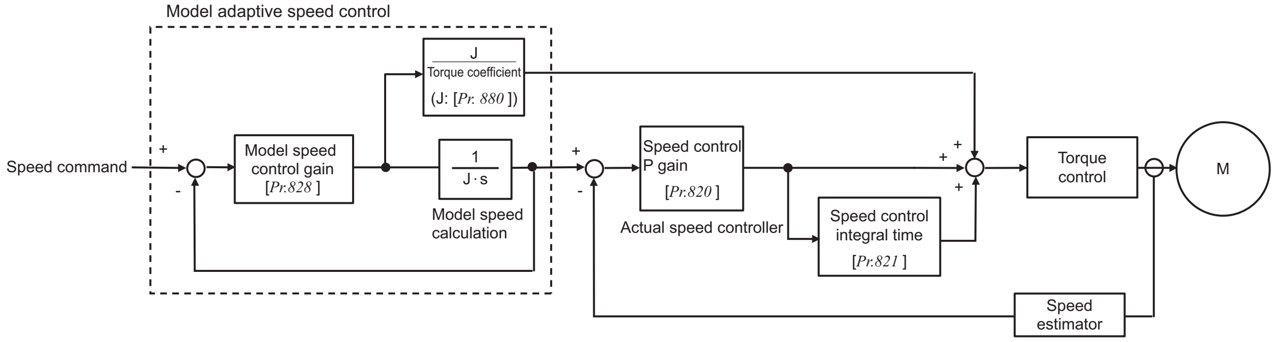
[Block diagram]



(2) Model adaptive speed control (*Pr.877* = "2")

- The motor's model speed is calculated to feed back the model side speed controller. This model speed is also used as the actual speed controller command.
- The inertia ratio of *Pr.880* is used when the model calculates the motor speed or the speed controller calculates the torque current command value.
- The torque current command value of the model side speed controller is added to the output of the actual speed controller, and the result is used as the iq current control input.
  Pr.828 is used for model side speed control (P control), and the first gain in *Pr.820* is used for the actual speed controller.

[Block diagram]

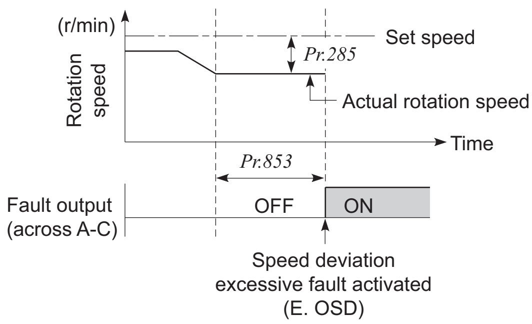


4.4.5 Excessive speed deviation (Pr.285, Pr.853)

Parameter number	Name	Initial value	Setting range	Description
285	**Excessive speed deviation detection speed**	9999	9999	Without speed deviation excessive
			0 to 360r/min *1	If the difference (absolute value) between the speed command value and actual speed during speed control exceeds the *Pr.285 Excessive speed deviation detection speed* for more than the time set in *Pr.853 Speed deviation time*, speed deviation excessive occurs and drive unit fault (E. OSD) appears, resulting in a trip.
853	**Speed deviation time**	1s	0 to 100s	

*1 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 900 r/min, 3.7K: 600 r/min)

- When the deviation between the set frequency and actual speed is large, e.g. too large load torque, this function can cause the drive unit to provide a speed deviation excessive fault (E.OSD) and come to a trip.



NOTE

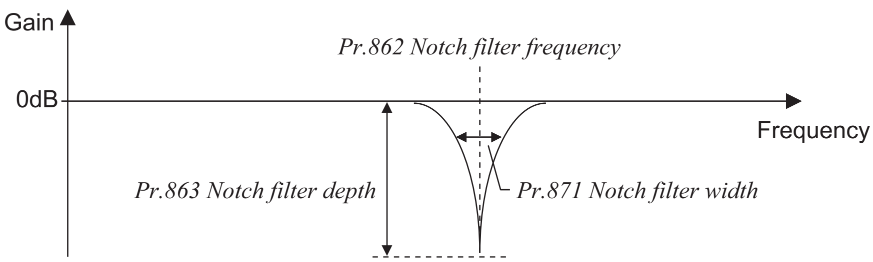
- **Under position control, speed deviation excess detection is disabled.**

4.4.6 Notch filter (Pr.862, Pr.863, Pr.871)

The response level of speed control in the resonance frequency band of mechanical systems can be lowered to avoid mechanical resonance.

Parameter number	Name	Initial value	Setting range	Description
862	**Notch filter frequency**	0	0	No notch filter
			10 to 625Hz	Set the frequency for the center of gain attenuation.
863	**Notch filter depth**	0	0 to 3	0 (Deep) → 3 (Shallow)
871	**Notch filter width**	0	0 to 3	0 (Narrow) → 3 (Wide)

- The mechanical resonance frequency is suppressed by setting the mechanical resonance frequency in *Pr.862 Notch filter frequency* and adjusting *Pr.863 Notch filter depth* and *Pr.871 Notch filter width*.
- If the mechanical resonance frequency is unknown, lower the notch frequency in order from the highest. The point where the resonance is smallest is the optimum setting for the notch frequency.
- In *Pr.863 Notch filter depth*, a deeper notch depth has a greater effect in reducing mechanical resonance, but because the phase delay is larger, vibration may increase. Adjust by starting from the shallowest value.
- In *Pr.871 Notch filter width*, a wider notch width has a greater effect in reducing mechanical resonance, but because the phase delay is larger, vibration may increase. Adjust by starting from the narrowest value.



4 PARAMETERS

4.4.7 Speed estimation gain and current control gain (Pr.730, Pr.824, Pr.825)

• Adjust if any of phenomena such as unusual vibration, noise, or overcurrent is produced by the motor or machinery.

Parameter number	Name	Initial value	Setting range	Description	
730	**Speed estimation P gain**	9999	0 to 300%	Set the proportional gain for the speed estimator.	
			9999	MM-GKR motor	The following value is set: 200% for 0.1K and 125% for 0.2K to 0.4K.
				S-PM geared motor	100% is set.
824	**Torque control P gain**	9999	0 to 200%	Set the current loop proportional gain.	
			9999	MM-GKR motor	The following value is set: 200% for 0.1K and 150% for 0.2K to 0.4K.
				S-PM geared motor	50% is set.
825	**Torque control integral time**	9999	0 to 50ms	Set current loop integral compensation time.	
			9999	MM-GKR motor	The following value is set: 2.5ms for 0.1K and 6.7ms for 0.2K to 0.4K.
				S-PM geared motor	20.0ms is set.

(1) Speed control P gain 2 *(Pr.730)*

• Set the proportional gain for the speed estimator with 200 rad/s as 100%.

• Setting this parameter higher improves the trackability for speed command changes. It also reduces the speed fluctuation caused by an external disturbance.

(2) Torque control P gain *(Pr.824)*

• The 100% current loop proportional gain is equivalent to 1000 rad/s.

• For general adjustment, make setting within the range 50 to 200% as a guideline.

• Set the proportional gain.

• Increasing the value improves trackability in response to a current command change and reduces current variation with disturbance. However, a too large gain will cause instability, generating harmonic torque pulsation.

(3) Torque control integral time *(Pr.825)*

• Set the integral time of current control.

• Decreasing the value shortens the time taken to return to the original torque if current variation with disturbance occurs.

(4) Adjustment procedure

Usually, use *Pr.820 and Pr.821* for adjustment of the speed control gain, and set "9999 (initial value)" in *Pr.730, Pr.824, and Pr.825*.

Make adjustment when any of such phenomena as unusual motor and machine vibration/noise/current and overcurrent has occurred.

1)Check the conditions and simultaneously change the *Pr.824* value.

2)If you cannot make proper adjustment, change the *Pr.825* value and repeat step 1).

Adjustment Method	
Set *Pr.824* a little lower and *Pr.825* a little higher. First lower *Pr.824* and check the motor for unusual vibration/noise and overcurrent. If the problem still persists, increase *Pr.825*.	
Pr.824	Decrease the value 10% by 10% until just before unusual noise and current are improved, and set about 0.8 to 0.9 of that value. Note that a too low value will produce current ripples, causing the motor to generate sound synchronizing the cycle of current ripples.
Pr.825	Increase the current value double by double until just before an unusual noise and current does not occur, and set about 0.8 to 0.9 of that value. Note that taking a too long time will produce current ripples, causing the motor to generate sound synchronizing the cycle of current ripples.

4.4.8 Adjusting the motor wiring resistance (Pr.658)

Adjust if acceleration/deceleration characteristics are unstable. In normal condition, setting is not required.

Parameter number	Name	Initial value	Setting range	Description
658 Ver.UP	Wiring resistance	9999	0 to 5 Ω	Set the motor wiring resistance. PM sensorless vector control is performed with the set resistance value.
			9999	The motor wiring resistance calculated by the drive unit is set. PM sensorless vector control is performed with the calculated resistance value.

Ver.UP ....Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

- The motor wiring resistance can be set. The set value is calculated according to the following formula.
  Wiring resistance = Resistance per 1 m (Ω) × Wiring length (m)
  Reference value

Cable size		Resistance per 1 m (Ω)	Resistance in the wiring length (Ω)					
HIV cables, etc. (mm^2)	AWG		1 m	2 m	5 m	10 m	20 m	30 m
0.75	19	0.029100	0.029	0.058	0.146	0.291	0.582	0.873
0.75	18	0.021800	0.022	0.044	0.109	0.218	0.436	0.654
2	14	0.008573	0.009	0.017	0.043	0.086	0.171	0.257

- For special size cables, the value is calculated according to the following formula.

$R(\Omega) = \rho \times \frac{\ell}{A}$ (ρ: constant 1.7241×10^{-2} ($\Omega \cdot mm^2/m$) (copper wire), A: cross section area (mm^2), ℓ: length (m))

4.5 Position control GKR

Purpose	Parameter to set		Refer to page
To perform simple position control by setting parameters	Parameter position command	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, Pr.525 to Pr.531, Pr.537, Pr.578 to Pr.591	95
To perform stop operation under position control	Position control sudden stop and stroke end	Pr.464, Pr.535	100
To perform more accurate positioning	Stopper control function	Pr.512 to Pr.515	102
To select the home position return method under position control	Position control home position return	Pr.110, Pr.111, Pr.453, Pr.455, Pr.508, Pr.509, Pr.532 to Pr.534	104
To relate the position command to actual travel distance	Electronic gear settings	Pr.420, Pr.421	108
To improve the precision of the position control	Settings of the positioning adjustment parameters	Pr.426, Pr.506, Pr.507, Pr.510, Pr.511, Pr.536	109
	Position control gain adjustment	Pr.422, Pr.423, Pr.427, Pr.446, Pr.463, Pr.698, Pr.877	92
	Speed control gain adjustment	Pr.820, Pr.821	80

4.5.1 Outline of position control

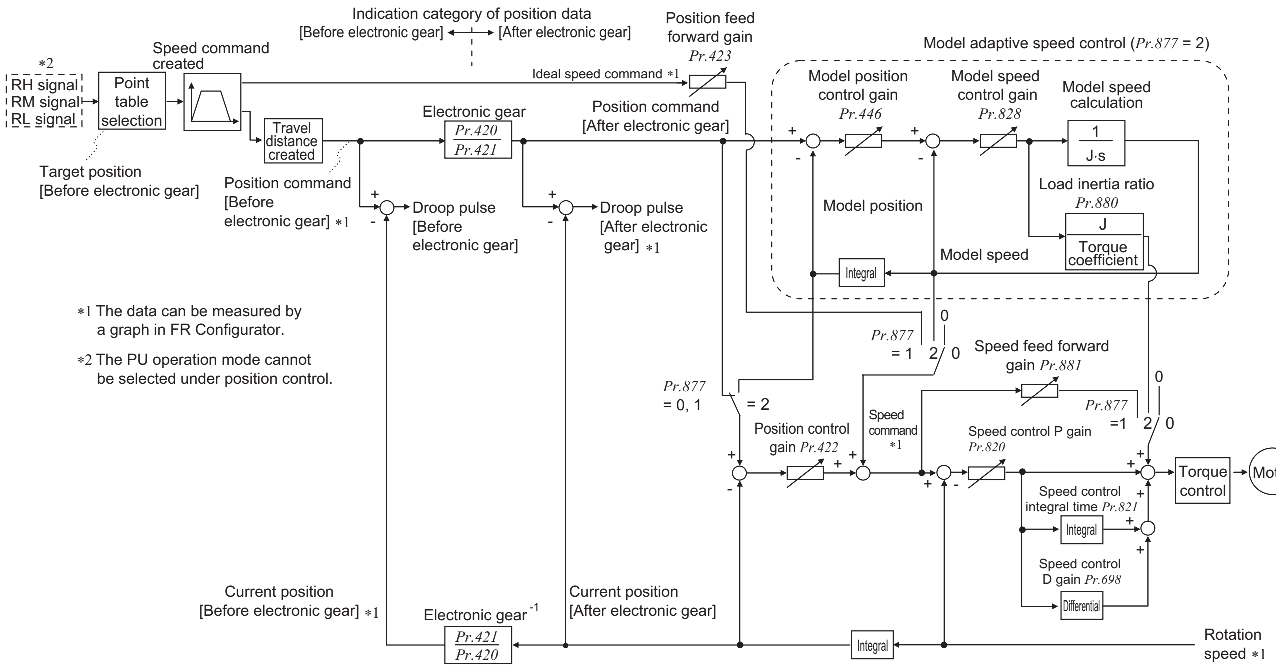
Under position control, a speed command is calculated to eliminate the difference between the position command and the current position for rotating the motor.
The position control is available when an MM-GKR motor is used.

(1) Position control specifications

Item		Specifications
Position command input method		Point table method
Command method	Interface	Input terminal selection, RS-485 communication, CC-Link communication (plug-in option)
	Number of points	7 points
	Command data setting range	-99999999 to 99999999
	Command setting method	Absolute position command with sign, increment command with sign
	Electronic gear ratio	1/900 to 900
Home position return method		Data set type, stopper type, ignore the home position (servo-ON position home position), count type with front end reference
Motor internal command resolution		5120 [kpulses/rev]
Positioning accuracy		±1.8° (Mechanical angle: Equivalent to the resolution of 200 [pulses/rev])
Other positioning functions		Sudden stop function, stroke end detection function, roll feed mode, JOG operation, stopper control function, pulse monitor selection function, position control rotation direction selection function

∗ Turning OFF the power or the SON signal (LX signal) eliminates the home position. After turning ON the power or the SON signal (LX signal), always perform the home position return. (For the roll feed, the home position return operation is not required.)

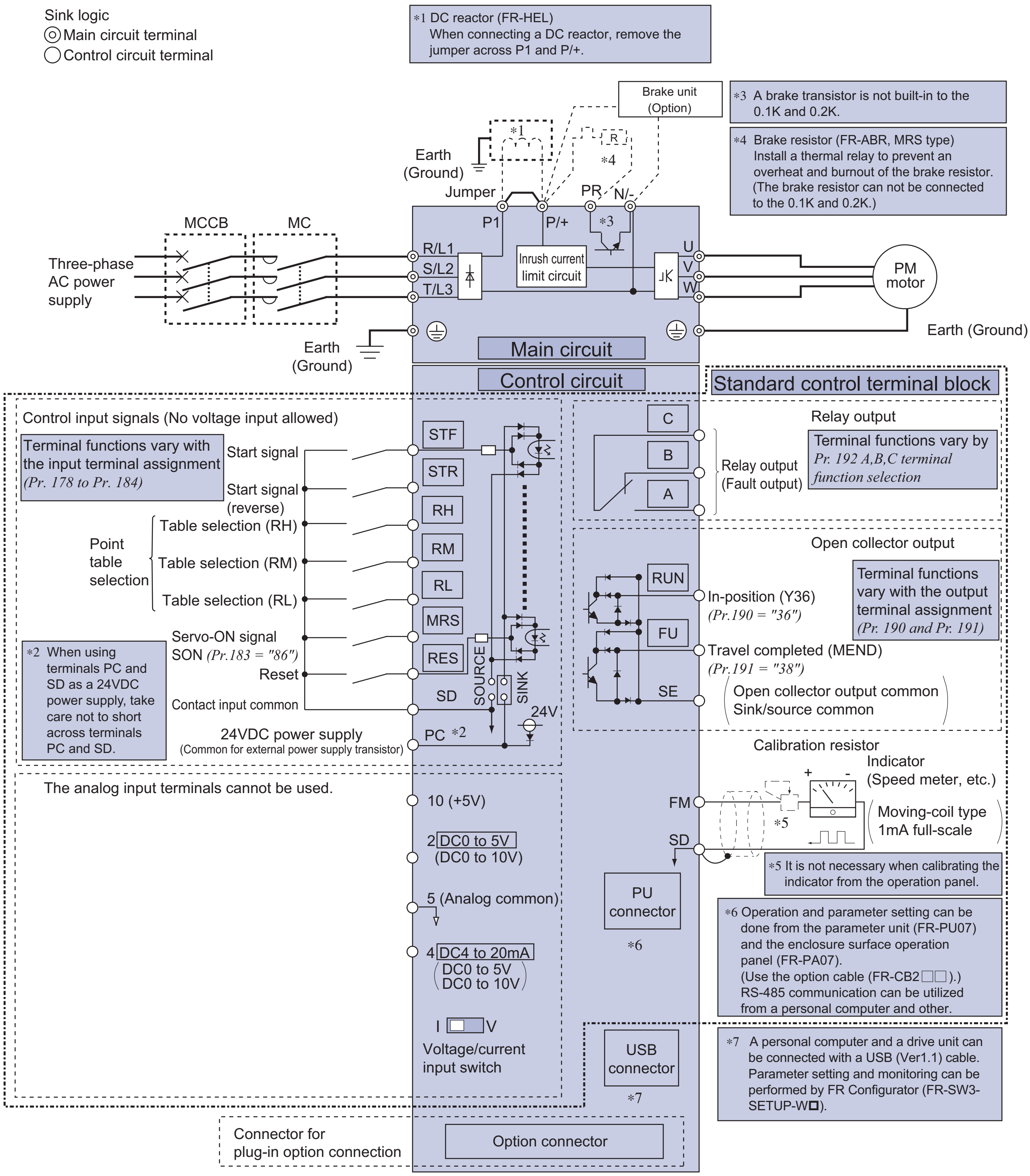
(2) Control block diagram



*1 The data can be measured by a graph in FR Configurator.

*2 The PU operation mode cannot be selected under position control.

(3) Connection example



NOTE

- **To prevent a malfunction caused by noise, separate the signal cables more than 10cm from the power cables. Also separate the main circuit wire of the input side and the output side.**
- **After wiring, wire offcuts must not be left in the drive unit.**
  Wire offcuts can cause an alarm, failure or malfunction. Always keep the drive unit clean. When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the drive unit.
- **Assign the SON signal under position control.** *(Refer to page 132)*

4.5.2 Setting procedure of position control

Perform secure wiring. *(Refer to page 90)*

↓

Change the parameter settings to the initial value in accordance with the applied motor. *(Pr.998) (Refer to page 73)*

"3024": Parameter settings for an MM-GKR motor (rotations per minute)
"3124": Parameter settings for an MM-GKR motor (frequency)

↓

Select the control method. *(Pr.800) (Refer to page 75)*

Set *Pr.800*="13" to enable position control.

↓

Motor rotation direction *(Pr.463) (Refer to page 92)*

Set the position pulse increase/decrease direction in *Pr.463*.

↓

Electronic gear settings *(Pr.420, Pr.421) (Refer to page 108)*

↓

Selection of I/O signals *(Pr.178 to Pr.184, Pr.190 to Pr.192) (Refer to page 138, 144)*

Assign "86 (SON signal)" or "23 (LX signal)" in one of *Pr.178 to Pr.184*.

↓

Home position return settings *(Pr.110, Pr.111, Pr.453, Pr.455, Pr.508, Pr.509, Pr.532 to Pr.534) (Refer to page 104)*

Set the pattern, shift distance, and others for the home position return.

↓

Set the parameters for positioning *(Pr.465 to Pr.478, Pr.525 to Pr.531, Pr.537, Pr.578 to Pr.591) (Refer to page 95)*

Set the target position, maximum speed, acceleration/deceleration time, and auxiliary function.

↓

Test run

As required

- JOG operation *(Refer to page 119)*
- Settings of the position adjustment parameters *(Refer to page 109)*
- Speed control gain setting *(Refer to page 80)*
- Position control gain adjustment *(Refer to page 92)*

NOTE

- **When position control is selected (*Pr.800*="13") for an S-PM motor (*Pr.998*="6004 or 6104"), the operation is performed under speed control.**

4.5.3 Gain adjustment of position control (Pr.422, Pr.423, Pr.427, Pr.446, Pr.463, Pr.698, Pr.877)

Parameter number	Name	Initial value	Setting range	Description
422	**Position control gain**	20sec^{-1}	0 to 150sec^{-1}	Set the gain of the position control.
423	**Position feed forward gain**	0%	0 to 100%	Function to cancel a delay caused by the droop pulses.
427	**Excessive level error**	40K pulses	0 to 400K pulses	If the droop pulse [after the electronic gear] exceeds the set value, the excessive position error (E.OD) occurs.
446	**Model position control gain**	0sec^{-1}	0 to 150sec^{-1}	Set the gain for the model position controller.
463	**Position control rotation direction selection**	0	0	The position pulse increases when the motor rotates CCW. The position pulse decreases when the motor rotates CW.
			1	The position pulse decreases when the motor rotates CCW. The position pulse increases when the motor rotates CW.
698	**Speed control D gain**	0%	0 to 100%	Set the differential gain of speed control. Valid only during positioning operation under position control.
877	**Feed forward control/model adaptive control selection**	0	0	Normal position control is performed.
			1	Feed forward control is performed.
			2	Model adaptive speed control is performed.

* The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Position loop gain *(Pr.422)*

- Make adjustment when any of such phenomena as unusual vibration, noise and overcurrent of the motor/machine occurs.
- Increasing the setting improves trackability for the position command and also improves servo rigidity at a stop, but oppositely makes an overshoot and vibration more liable to occur. The droop pulse amount is determined according to the following formula.

$$\text{Droop pulse amount (pulse)} = \frac{\dfrac{\text{Rotation speed (r/min)}}{60} \times \dfrac{\text{Motor internal command resolution}}{\text{(5120 pulses/rev)}}}{\textit{Pr.422 Position control gain}\ (\text{sec}^{-1})}$$

- With the actual speed response of 100 rad/s (sec^{-1}) to 200 rad/s (sec^{-1}), set *Pr.422* so that the position control gain is 1/10 to 1/3 of the actual speed response. As a guideline, normally set the position control gain in a range between 5 to 50 rad/s (sec^{-1}).
  Example) With the actual speed response of 200 rad/s, when setting *Pr.422* to 1/10 of the speed response
  Pr.422 = 200rad/s(sec^{-1}) × 1/10 = 20rad/s(sec^{-1})

Phenomenon/Condition	*Pr.422* Adjustment
Slow response	Increase the setting value. Increase the value 3rad/s(sec^{-1}) by 3rad/s(sec^{-1}) until just before an overshoot, stop-time vibration or other instable phenomenon occurs, and set about 0.8 to 0.9 of that value.
Overshoot, stop-time vibration or other instable phenomenon occurs.	Decrease the setting value. Decrease the value 3rad/s(sec^{-1}) by 3rad/s(sec^{-1}) until just before an overshoot, stop-time vibration or other instable phenomenon does not occur, and set about 0.8 to 0.9 of that value.

(2) Position feed forward gain (*Pr.423, Pr.877* = "1")

- This function is designed to cancel a delay caused by the droop pulses.
- When the position response or speed response (trackability of the speed command) is low, adjust *Pr.423*.
- Set a small value in *Pr.423* first, and then increase the value gradually until the target position response or speed response is acquired. Set this parameter within the range where an overshoot or vibration will not occur. The guideline value is approximately 90%.
- This function has no effects on servo rigidity at a stop.

(3) Model adaptive speed control (*Pr.446, Pr.877* = "2")

- The model speed of the motor is calculated, and the feedback is applied to the position controller on the model side. Also, this model position is set as the command of the actual position controller.
- The *Pr.446* setting is used for the gain of the model position controller and the *Pr.422* setting is used for the actual position control gain.
- The inertia ratio of *Pr.880* is used when the model calculates the motor speed or the speed controller calculates the torque current command value.
- The torque current command of the speed controller and calculation of the motor speed on the model side are added to the output of the actual speed controller, and set as the input of the iq current control.
  Pr.828 is used for the speed control on the model side (P control), and first gain *Pr.820* is used for the actual speed controller.

(4) Speed control D gain *(Pr.698)*

- Adjusting *Pr.698 Speed control D gain* suppresses unstable movement (vibration). This is useful when the machine has difficulty in stopping at the target position (vibrated around the target position) during positioning operation under position control.

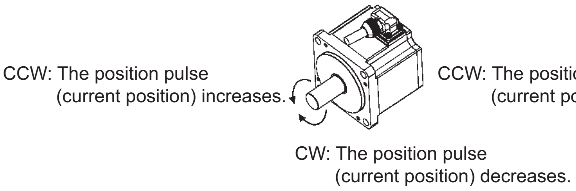
  Setting *Pr.698* = 100% sets the corner frequency of ωf = 10rad/s (ωf = 10rad/s×*Pr.698* [%])and reduces the response level to the frequency lower than that. Position deviation, however, increases as a higher value is set in *Pr.698*.

(5) Excessive error level *(Pr.427)*

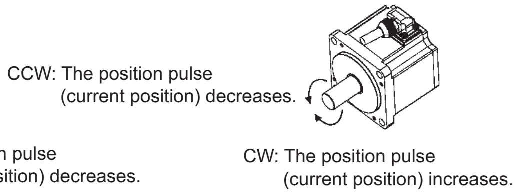
- If the number of droop pulses [after the electronic gear] exceeds the *Pr.427 Excessive level error* setting, an error (E.OD) is displayed and the operation is stopped. If a small value is set in *Pr.422 Position control gain*, the droop pulse is increased. Thus, set a large value in *Pr.427*.
  To detect the excessive position error at an overload early, set a small value.
  Number of droop pulses [after electronic gear] = Position command [after electronic gear] - Current position [after electronic gear]

(6) Motor rotation direction and position pulse accumulation *(Pr.463)*

- When *Pr.463 Position control rotation direction selection* = "0", the position pulse (current position) increases in the CCW rotation seen from the motor shaft, and decreases in the CW rotation seen from the motor shaft.
- When *Pr.463 Position control rotation direction selection* = "1", the position pulse (current position) decreases in the CCW rotation seen from the motor shaft, and increases in the CW rotation seen from the motor shaft.



For *Pr.463* = "0"



For *Pr.463* = "1"

NOTE

- ***Pr.463* can be written while the operation is stopped (while the start signal of the drive unit is OFF and the output is shut off), and the setting is applied immediately.**
  Setting cannot be written during operation.

(7) Troubleshooting (for position control)

Condition	Cause	Countermeasure
The motor does not rotate.	(1) The phase sequence of motor wiring is incorrect. (2) The setting of *Pr.800* is not appropriate. (3) Any of the following signals are not input: servo-ON signal (SON), pre-excitation signal (LX), point table selection signal (RH, RM, or RL), and start signal (STF or STR). (4) Any of the following signals are input: position control sudden stop signal (X87) (normally closed), forward stroke end signal (LSP) (normally closed), reverse stroke end signal (LSN) (normally closed), and PU stop signal. (5) The target position setting in *Pr.465 to Pr.485* is incorrect. (6) The number of droop pulses [after the electronic gear] has exceeded the *Pr.427 Excessive level error* setting.	(1) Check the wiring. (2) Check the *Pr.800* setting. (3) Check if the signals are properly input. (4) Check if the signals are properly input. (5) Check the target position setting in *Pr.465 to Pr.485*. (6) Check the *Pr.427 Excessive level error* setting.
The position is unfavorably shifted.	(1) The point table selection signal (RH, RM, or RL) is not input. (2) The electronic gear settings in *Pr.420 and Pr.421* are incorrect.	(1) Check the wiring. (2) Check the electronic gear settings by *Pr.420 and Pr.421*.
Hunting occurs in the motor or the machine.	(1) Position loop gain is too high. (2) Speed loop gain is too high.	(1) Set *Pr.422* lower. (2) Set *Pr.820* lower and *Pr.821* higher.
Machine movement is unstable.	(1) Acceleration/deceleration time settings are affecting adversely.	(1) Set the acceleration/deceleration time *(Pr.578 to Pr.591)* lower.

4.5.4 Simple positioning function by point tables (Pr.4 to 6, Pr.24 to Pr.27, Pr.465 to Pr.478, Pr.508, Pr.509, Pr.525 to Pr.531, Pr.537, Pr.578 to Pr.591)

Set positioning parameters such as the number of pulses (position) and acceleration/deceleration time in advance to create point tables (point table method). Positioning operation is performed by selecting the point table.

Parameter number	Name	Initial value	Setting range	Description
4	**Multi-speed setting (high speed)**	3000r/min	0 to 4800r/min*1	Maximum speed at the first positioning
5	**Multi-speed setting (middle speed)**	1500r/min	0 to 4800r/min*1	Maximum speed at the second positioning
6	**Multi-speed setting (low speed)**	300r/min	0 to 4800r/min*1	Maximum speed at the third positioning
24	**Multi-speed setting (speed 4)**	9999	0 to 4800r/min*1, 9999	Maximum speed at the forth positioning When *Pr.24* = "9999", the *Pr.6* setting is used.
25	**Multi-speed setting (speed 5)**	9999	0 to 4800r/min*1, 9999	Maximum speed at the fifth positioning When *Pr.25* = "9999", the *Pr.6* setting is used.
26	**Multi-speed setting (speed 6)**	9999	0 to 4800r/min*1, 9999	Maximum speed at the sixth positioning When *Pr.26* = "9999", the *Pr.5* setting is used.
27	**Multi-speed setting (speed 7)**	9999	0 to 4800r/min*1, 9999	Maximum speed at the seventh positioning When *Pr.27* = "9999", the *Pr.6* setting is used.
465	**First target position lower 4 digits**	0	0 to 9999	Set the target position data before the electronic gear. The data consists of the upper data and lower data.
466	**First target position upper 4 digits**			
467	**Second target position lower 4 digits**			
468	**Second target position upper 4 digits**			
469	**Third target position lower 4 digits**			
470	**Third target position upper 4 digits**			
471	**Fourth target position lower 4 digits**			
472	**Fourth target position upper 4 digits**			
473	**Fifth target position lower 4 digits**			
474	**Fifth target position upper 4 digits**			
475	**Sixth target position lower 4 digits**			
476	**Sixth target position upper 4 digits**			
477	**Seventh target position lower 4 digits**			
478	**Seventh target position upper 4 digits**			
508	**Home position shift amount lower 4 digits**	0	0 to 9999	Set an offset value to shift the home position.
509	**Home position shift amount upper 4 digits**			
525	**First positioning sub-function**	10	(see below)	Set a function of the target position data.
526	**Second positioning sub-function**			
527	**Third positioning sub-function**			
528	**Fourth positioning sub-function**			
529	**Fifth positioning sub-function**			
530	**Sixth positioning sub-function**			

Setting range	Sign	Command method	Continuous operation
0	Plus	Absolute position command	Independent
1	Plus	Absolute position command	Continuous
10	Plus	Increment command	Independent
11	Plus	Increment command	Continuous
100	Minus	Absolute position command	Independent
101	Minus	Absolute position command	Continuous
110	Minus	Increment command	Independent
111	Minus	Increment command	Continuous

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Parameter number	Name	Initial value	Setting range	Description		
531	**Seventh positioning sub-function**	10	0	Plus	Absolute position command	Independent
			10	Plus	Increment command	Independent
			100	Minus	Absolute position command	Independent
			110	Minus	Increment command	Independent
537	**Roll feed mode selection**	0	0	Point table position control based on the absolute position		
			1	Point table position control in the roll feed mode		
578	**First positioning acceleration time**	5s	0.01 to 360s	Set the basis of acceleration/deceleration time in *Pr.20 Acceleration/deceleration reference speed*. Set acceleration/deceleration time within the range of "stop" to the speed change time set in *Pr.20*.		
579	**First positioning deceleration time**					
580	**Second positioning acceleration time**					
581	**Second positioning deceleration time**					
582	**Third positioning acceleration time**					
583	**Third positioning deceleration time**					
584	**Fourth positioning acceleration time**					
585	**Fourth positioning deceleration time**					
586	**Fifth positioning acceleration time**					
587	**Fifth positioning deceleration time**					
588	**Sixth positioning acceleration time**					
589	**Sixth positioning deceleration time**					
590	**Seventh positioning acceleration time**					
591	**Seventh positioning deceleration time**					

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

(1) Point table setting *(Pr.4 to 6, Pr.24 to Pr.27, Pr.465 to Pr.478, Pr.525 to Pr.531, Pr.537, Pr.578 to Pr.591)*

- Assign the target position, speed, and acceleration/deceleration time to the point tables and select the tables using the RH, RM, and RL signals.

Point table	Position data [Before electronic gear] *1		Maximum speed *2	Acceleration time *3	Acceleration time *3	Auxiliary function	Table selection signal		
	Upper	Lower					RH	RM	RL
0	Home position return mode						×	×	×
1	*Pr.466*	*Pr.465*	*Pr.4*	*Pr.578*	*Pr.579*	*Pr.525*	○	×	×
2	*Pr.468*	*Pr.467*	*Pr.5*	*Pr.580*	*Pr.581*	*Pr.526*	×	○	×
3	*Pr.470*	*Pr.469*	*Pr.6*	*Pr.582*	*Pr.583*	*Pr.527*	×	×	○
4	*Pr.472*	*Pr.471*	*Pr.24*	*Pr.584*	*Pr.585*	*Pr.528*	×	○	○
5	*Pr.474*	*Pr.473*	*Pr.25*	*Pr.586*	*Pr.587*	*Pr.529*	○	×	○
6	*Pr.476*	*Pr.475*	*Pr.26*	*Pr.588*	*Pr.589*	*Pr.530*	○	○	×
7	*Pr.478*	*Pr.477*	*Pr.27*	*Pr.590*	*Pr.591*	*Pr.531*	○	○	○

*1 Position commands are accepted after the home position return operation is completed. New position data are not accepted during home position return operation.
*2 The maximum speed does not exceed a speed equivalent to the speed command set in *Pr.1 Maximum setting*. The *Pr.2 Minimum setting* is ignored.
*3 During position control, acceleration/deceleration pattern is always the liner acceleration/deceleration, and the *Pr.29 Acceleration/deceleration pattern selection* setting is ignored.
Even when the RT signal is input, this setting is applied to the operation (the second deceleration time is ignored).
If the acceleration/deceleration time setting is 12r/min/1s or lower, the slope of 12r/min/1s is applied to acceleration/deceleration.

- Set the function of the target position data in *Pr.525 to Pr.531* auxiliary function.

Item		Description
Sign	Plus	Sets the target position data as a plus value.
	Minus	Sets the target position data as a minus value.
Command method	Absolute position command	A command is given based on the absolute position from the home position. Position commands cannot be received until the completion of the home position return. (The position control is not performed.)
	Increment command	A command is given based on increments from the current position.
Continuous operation	Independent	Positioning is performed once according to one selected point table.
	Continuous *1	After positioning is completed, another positioning is performed continuously according to the next point table.

*1 "Continuous" cannot be set in *Pr.531 Seventh positioning sub-function*.

- To perform position control, turn ON the SON signal or the LX signal. For the SON signal and the LX signal, refer to *page 131.*
  To input the SON signal, set "86" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
  To input the LX signal, set "23" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- When performing position control, always perform the home position return. However, the home position return is not required when the roll feed mode (*Pr.537* = "1") is selected. For the home position return, refer to *page 104*.
- When the start signal (STF signal or STR signal) is turned ON, the selection of the point table (RH, RM, or RL) is determined and position shift is started.
- When an increment command is selected and the STR signal is used as a start signal, the sign of position data is reversed. When an increment command is selected, the sign of position data is not reversed even if the STR signal is used as a start signal.

Auxiliary function setting *(Pr.525 to Pr.531)*	Command method	Increment command		Absolute position command	
	Sign	Plus	Minus	Plus	Minus
Forward rotation command (STF signal)		Plus	Minus	Plus	Minus
Reverse rotation command (STR signal)		Minus	Plus	Plus	Minus

- When an increment command is used and the target position is set out of the command data setting range (-99999999 to 99999999), the target position is regarded as 99999999 (for plus) or -99999999 (for minus) to continue the position control.

NOTE

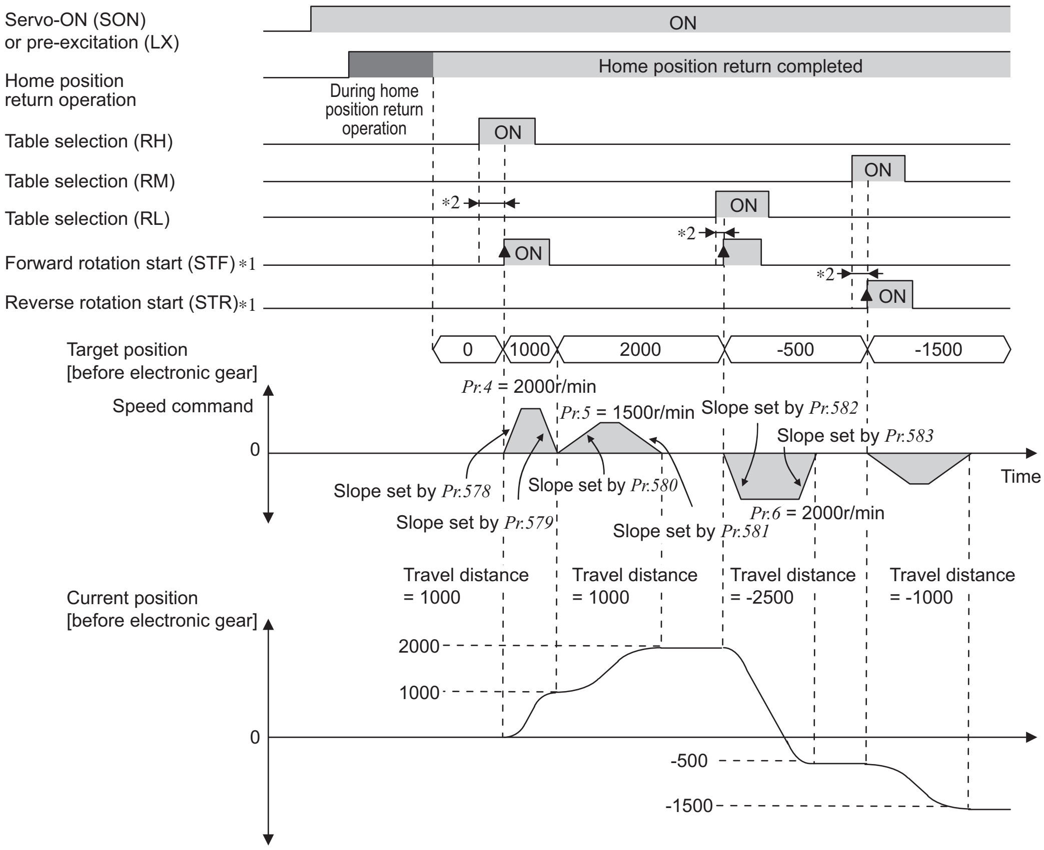
- **Do not set 0 r/min in the maximum speed of the point table *(Pr.4 to Pr.6 and Pr.24 to Pr.27)*. If 0r/min is set, no position command is created and the stop state remains. In such a case, turn OFF the SON signal (or LX signal), and then perform the home position return again.**
- **The priorities of the external signals are "JOG signal (JOG) > JOG signal 2 (JOG2) > point table selection signal (RH, RM, or RL).**
- **The *Pr.13 Starting speed* setting is ignored.**

(2) Operation example

- The following shows an operation example with the parameter setting shown in the table below.

<Point table position control based on the absolute position (*Pr.537* = "0")>

Point table	Position data [Before electronic gear]	Maximum speed	Acceleration time	Deceleration time	Auxiliary function	Table selection signal		
						RH	RM	RL
1	*Pr.465* = "1000", *Pr.466* = "0"	*Pr.4* = "2000r/min"	*Pr.578* = "1s"	*Pr.579* = "1s"	*Pr.525* = "1"	○	×	×
2	*Pr.467* = "1000", *Pr.468* = "0"	*Pr.5* = "1500r/min"	*Pr.580* = "2s"	*Pr.581* = "2s"	*Pr.526* = "10"	×	○	×
3	*Pr.469* = "500", *Pr.470* = "0"	*Pr.6* = "2000r/min"	*Pr.582* = "1s"	*Pr.583* = "1s"	*Pr.527* = "100"	×	×	○



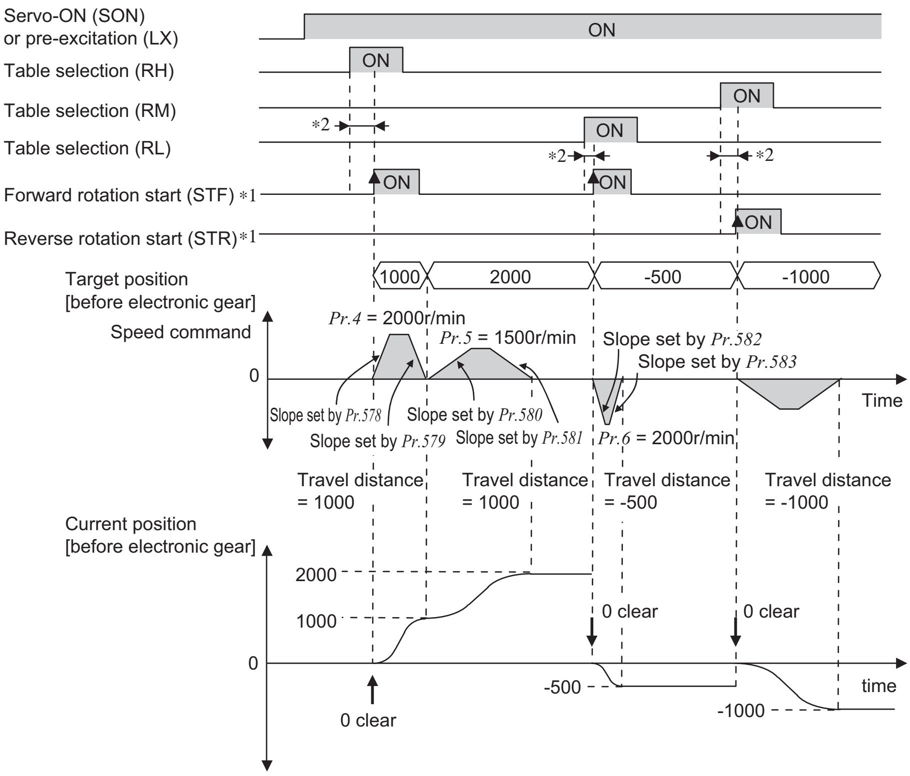
*1 The start command must remain ON for 20 ms or longer.

*2 Wait for 5 ms or longer after the table selection signal is turned ON. Then, turn ON the start signal.

(3) Roll feed mode (*Pr.537* = "1")

- The current position and position command are set to 0 at start, and then position control is performed.
- Because the current position and position command are set to 0 at start, position commands are not overflowed and the repeated feed by the increment is available.
- With this setting, no home position return is required.
- The following shows an operation example with the parameter setting shown in the table below.
  <Point table position control in the roll feed mode (*Pr.537* = "1")>

Point table	Position data [Before electronic gear]	Maximum speed	Acceleration time	Deceleration time	Auxiliary function	Table selection signal		
						RH	RM	RL
1	*Pr.465* = "1000", *Pr.466* = "0"	*Pr.4* = "2000r/min"	*Pr.578* = "1s"	*Pr.579* = "1s"	*Pr.525* = "1"	○	×	×
2	*Pr.467* = "1000", *Pr.468* = "0"	*Pr.5* = "1500r/min"	*Pr.580* = "2s"	*Pr.581* = "2s"	*Pr.526* = "10"	×	○	×
3	*Pr.469* = "500", *Pr.470* = "0"	*Pr.6* = "2000r/min"	*Pr.582* = "1s"	*Pr.583* = "1s"	*Pr.527* = "100"	×	×	○



*1 The start command must remain ON for 20 ms or longer.

*2 Wait for 5 ms or longer after the table selection signal is turned ON. Then, turn ON the start signal.

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4.5.5 Stop operation under position control (Pr.464, Pr.535)

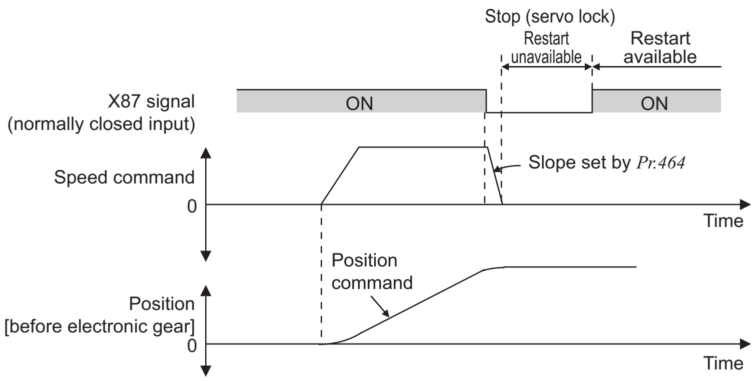
While position control is being performed, the operation can be stopped via input terminals.

<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th colspan="3">Description</th></tr>
<tr><td>464</td><td>Position control sudden stop deceleration time</td><td>0.01s</td><td>0.01 to 360s</td><td colspan="3">Set the deceleration time when the operation is stopped by inputting the sudden stop signal, forward stroke end signal, or reverse stroke end signal.
Set the basis of deceleration time in Pr.20 Acceleration/ deceleration reference speed. Set the speed change time from Pr.20 to "stop" as the deceleration time.</td></tr>
<tr><td rowspan="10">535</td><td rowspan="10">Position control terminal input selection</td><td rowspan="10">0</td><td rowspan="2"></td><td colspan="3">The input logic can be selected for X87, LSP, and LSN.
Normally open: The operation is stopped when the contact between SD and each signal is closed.
Normally closed: The operation is stopped when the contact between SD and each signal is opened.</td></tr>
<tr><td>LSN</td><td>LSP</td><td>X87</td></tr>
<tr><td>0</td><td rowspan="4">Normally open</td><td rowspan="2">Normally open</td><td>Normally open</td></tr>
<tr><td>1</td><td>Normally closed</td></tr>
<tr><td>10</td><td rowspan="2">Normally closed</td><td>Normally open</td></tr>
<tr><td>11</td><td>Normally closed</td></tr>
<tr><td>100</td><td rowspan="4">Normally closed</td><td rowspan="2">Normally open</td><td>Normally open</td></tr>
<tr><td>101</td><td>Normally closed</td></tr>
<tr><td>110</td><td rowspan="2">Normally closed</td><td>Normally open</td></tr>
<tr><td>111</td><td>Normally closed</td></tr>
</table>

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Sudden stop (X87 signal)

- When the X87 signal (position control sudden stop signal) is assigned to the input terminal, the operation stops according to the deceleration time slope set by *Pr.464 Position control sudden stop deceleration time* by turning OFF the signal (normally closed input). However, when the deceleration time set in *Pr.464 Position control sudden stop deceleration time* is longer than that set by the current position control command, the deceleration time slope set by the current position control command is applied. After the operation is stopped, turning ON the X87 signal starts position control again. To input the X87 signal, set "87" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- When the ones digit of the set value in *Pr.535 Position control terminal input selection* is "0", the normally open input is applied and the operation is stopped by turning ON the X87 signal.

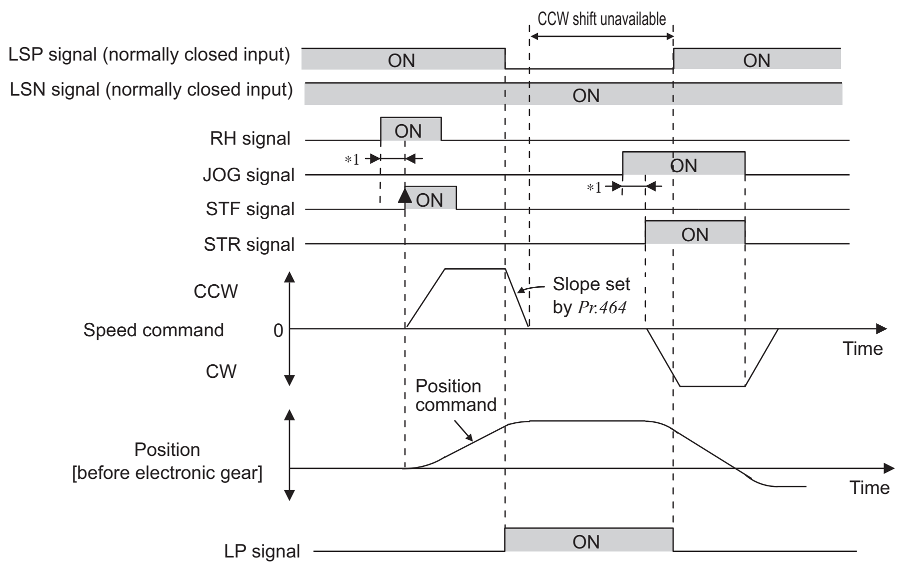


NOTE

- **The operation is inactive under speed control.**

(2) Stroke end setting (LSP signal, LSN signal, and LP signal)

- When the LSP signal (forward stroke end signal) or the LSN signal (reverse stroke end signal) is assigned to the input terminal, the operation stops according to the deceleration time slope set by *Pr.464 Position control sudden stop deceleration time* by turning OFF the signal (normally closed input). However, when the deceleration time set in *Pr.464 Position control sudden stop deceleration time* is longer than that set by the current position control command, the deceleration time set by the current position control command is applied.
  After stopped, the motor cannot be rotated in the CCW (CW) direction while the LSP signal (LSN signal) is OFF.
  To input the LSP signal, set "88" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
  To input the LSN signal, set "89" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- When the LSP signal or LSN signal is OFF (normally closed input), the position can be rotated CCW (CW) by the position control JOG operation.
- When the LSP signal or LSN signal is OFF (normally closed input), the stroke limit warning signal (LP signal) is turned ON and "LP" flickers on the operation panel. Set "24 (positive logic)" or "124 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)* to assign the stroke limit warning signal (LP signal).
- When the tens digit (hundreds digit) of the set value in *Pr.535 Position control terminal input selection* is 0, the normally open input is applied and the operation is stopped by turning ON the LSP (LSN) signal. When "1" is set, the normally closed input is applied and the operation is stopped by turning OFF the LSP signal (LSN signal).



*1 Wait for 5 ms or longer after the table selection signal is turned ON. Then, turn ON the start signal.

Stroke end input (normally closed input)		Operation availability	
LSP (forward stroke end)	**LSN (reverse stroke end)**	**CCW**	**CW**
ON	ON	Available	Available
OFF	ON	Unavailable	Available
ON	OFF	Available	Unavailable
OFF	OFF	Unavailable	Unavailable

NOTE

- **The operation is inactive under speed control.**

4

PARAMETERS

4.5.6 Stopper control function (Pr.512 to Pr.515, X29 signal)

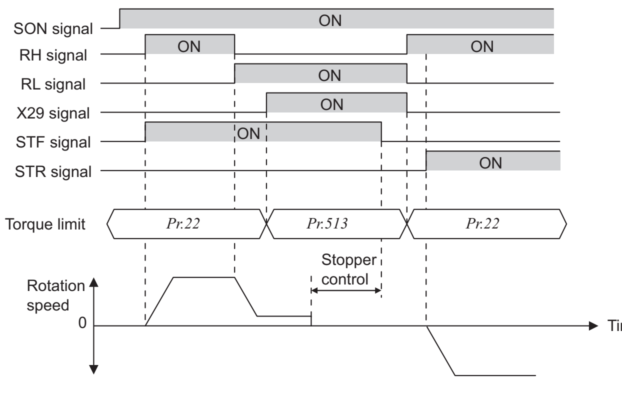
Under stopper control, the motor outputs holding torque to press a workpiece to a mechanical stopper for more accurate positioning. This function enables a stable stop for positioning.

Parameter number	Name	Initial value	Setting range	Description
512	**Stopper control function selection**	0		Set a condition to apply the *Pr.513* setting, not to activate, and E.OLT.
			0	Stopper control disabled
			1	When the X29 signal is turned ON (speed control, position control)
			10	Under position control, Current position [before electronic gear] ≥ *Pr.515* + *Pr.514* or Current position [before electronic gear] ≤ -(*Pr.515* + *Pr.514*)
			11	Under position control, Current position [before electronic gear] ≥ *Pr.515* + *Pr.514*
			12	Under position control, Current position [before electronic gear] ≤ -(*Pr.515* + *Pr.514*)
513	**Stopper control torque limit**	40%	0 to 200%	Set the torque limit value under stopper control.
514	**Stopper control switchover position lower 4 digits**	0	0 to 9999	When the current position [before the electronic gear] enters the range set by *Pr.512* under position control, the torque limit operation is activated according to the *Pr.513* setting.
515	**Stopper control switchover position upper 4 digits**	0	0 to 9999	

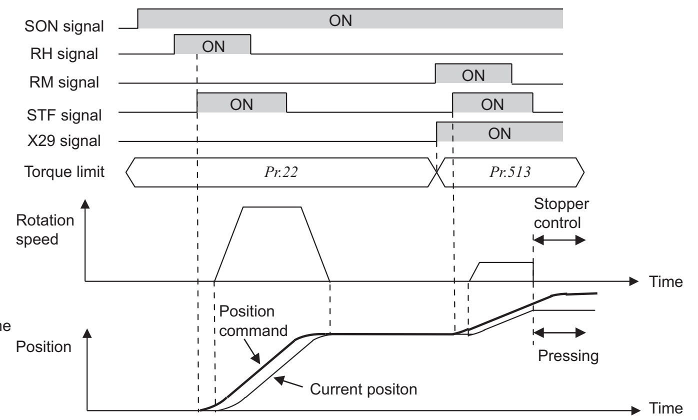
The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Stopper control by the X29 signal (*Pr.512* = "1", *Pr.513*, X29 signal)

- When the X29 signal (stopper control switchover signal) is assigned to the input terminal, the *Pr.513* setting is applied and E.OLT is disabled.
  To input the X29 signal, set "29" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- Stopper control by the X29 signal is compatible with both speed control or position control.
- When *Pr.513 Stopper control torque limit* has been activated and has stopped the motor, E.OLT does not occur, but the electronic thermal O/L relay is activated. Thus, performing stopper control at a high load for a long time may cause the motor overload trip fault (E.THM) or drive unit overload trip fault (E.THT).
- The *Pr.513* setting must be 80% or lower to prevent the motor from overheating.



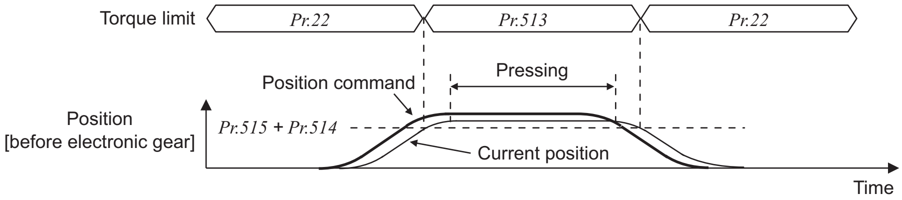
Example of speed control



Example of position control

(2) Stopper control by torque limit automatic switching under position control *(Pr.512 to Pr.515)*

- When the current position [before the electronic gear] exceeds the stopper control switching position (*Pr.515* + *Pr.514*), the *Pr.513* setting is applied and E.OLT is disabled.
- Select the valid stopper control switching position (*Pr.515* + *Pr.514*) from the following using *Pr.512 Stopper control function selection* : both the plus and minus positions, plus position only, or minus position only.
- When *Pr.513 Stopper control torque limit* has been activated and has stopped the motor, E.OLT does not occur, but the electronic thermal O/L relay is activated. Thus, performing stopper control at a high load for a long time may cause the motor overload trip fault (E.THM) or drive unit overload trip fault (E.THT).



REMARKS

- If the torque limit operation is disabled by *Pr.156 Torque limit selection*, this function is disabled.
- With *Pr.156* set to any of "16 to 29", when the OL signal is output while a workpiece is pressed, the output of the drive unit is shut off by E.OLT.
- If the home position return is not performed under position control in other than the roll feed mode, the position at servo-ON (pre-excitation) is set as the home position.
- Under position control in the roll feed mode, the position at startup is set as the home position.
- If the stopper control torque limit operation at high level is performed for a long time, a resistance error occurs due to a temperature change of the motor, and this error may cause a position error.
- The droop pulses during stopper control under position control are held, causing an operation delay corresponding to the droop pulses after the stopper is released.

4

PARAMETERS

4.5.7 Home position return under position control (Pr.110, Pr.111, Pr.453, Pr.455, Pr.508, Pr.509, Pr.532 to Pr.534)

Determine the home position for the position control. Position control with an absolute position cannot be performed until the home position is set.

Parameter number	Name	Initial value	Setting range		Description
110	**Acceleration time for home position return**	5s	0.01 to 360s		Set an acceleration time from 0r/min to *Pr.20*.
111	**Deceleration time for home position return**	5s	0.01 to 360s		Set a deceleration time from *Pr.20* to 0r/min.
453	**High speed during home position return**	300r/min	0 to 4800r/min ∗1		Maximum speed at high-speed home position return
455	**Home position return shifting speed**	1500r/min	0 to 4800r/min ∗1		Maximum speed at home position return
508	**Home position shift amount lower 4 digits**	0	0 to 9999		Set an offset value to shift the home position.
509	**Home position shift amount upper 4 digits**	0	0 to 9999		
532	**Home position return selection**	4	2		Data set type
			3		Stopper type
			4		Ignoring the home position (servo-ON position as the home position)
			6		Count type with front end reference
533	**Home position return stopper torque**	40%	0 to 200%		Set a torque limit for the pressing home position return.
534	**Home position return stopper duration**	0.5s	0 to 10s		Set a pressing time for the pressing home position return.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

∗1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

(1) Home position return pattern selection *(Pr.532)*

- Use *Pr.532* to set a pattern of home position return. The following operation is performed according to the control mode.
- To perform home position return, turn ON the start signal (STF signal or STR signal) without selecting a point table and JOG operation (RH, RM, RL, and JOG are OFF).
- Home position return is started when the start signal (STF signal or STR signal) is turned ON (at the leading edge).
- For PM sensorless vector control, position detection is not performed by a sensor such as an encoder but by energizing the motor. Thus, turning OFF the SON signal or the LX signal eliminates the home position. After turning ON the SON signal (LX signal), always perform the home position return. In addition, when the power is turned OFF, the home position is eliminated. After turning ON the power, always perform the home position return.
- Under speed control, home position return cannot be performed. To perform home position return, always select the position control mode.

Pr.532 setting	Type	Description
2	Data set type	Set a position as the home position.
3	Stopper type	Home position return is performed pressing a workpiece on the machine end. The home position return direction can be selected. The home position shift distance can be set.
4	Ignoring the home position (servo-ON position as the home position)	The servo-ON position is used as the home position.
6	Count type with front end reference	The front end of the proximity dog is set as the home position. The home position return direction can be selected. The home position shift distance can be set.

NOTE

- **Turning OFF the power or the SON signal (LX signal) eliminates the home position. After turning ON the power or the SON signal (LX signal), always perform the home position return. (For the roll feed, the home position return operation is not required.)**

(2) Home position return completed signal (ZP signal) and home position return failure warning signal (ZA signal)

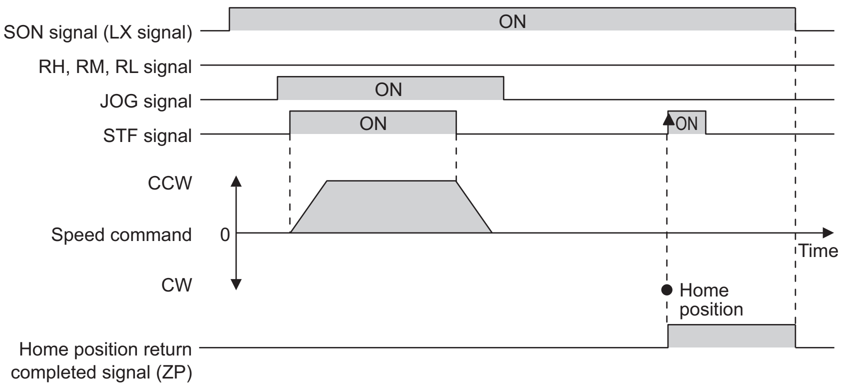
- When home position return is completed, the home position return completed signal (ZP) is turned ON. If home position return is performed after home position return is completed once, the home position return completed signal (ZP) is turned OFF during the second home position return, and then turned ON after the second home position return is completed.
  For the home position return completed signal (ZP), assign the function by setting "63 (positive logic) or 163 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.
- If an error occurs in home position return, the home position return failure warning signal (ZA) is turned ON and "HP1" or "HP2" flickers on the operation panel. When home position return is retried and then normally completed, the home position return failure warning signal (ZA) is turned OFF. (Even though the SON signal (LX signal) is OFF, the home position return failure warning signal (ZA) is turned OFF.) For the home position return failure warning signal (ZA), assign the function by setting "56 (positive logic) or 156 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

Warning indication	Warning name	Description
HP1	Home position return setting error	Home position return has not been completed normally.
HP2	Home position return uncompleted	A position command according to a point table has been input when home position return is not completed yet. (Except in the roll feed mode)

- Unless home position return is completed (the home position return completed signal (ZP) is turned ON), position control cannot be performed (position control JOG operation is available).

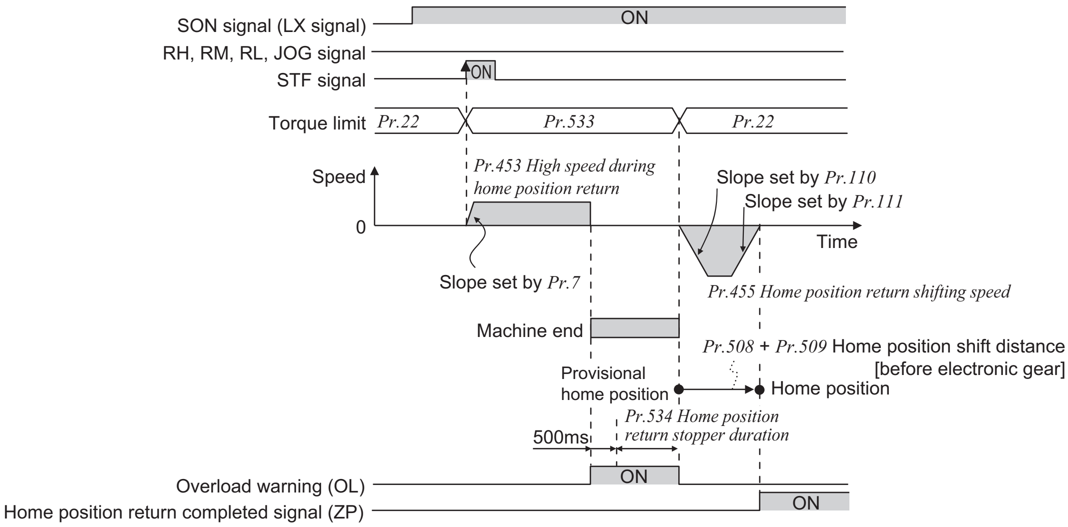
(3) Data set type (*Pr.532* = "2")

- In this mode, set a position to be set as the home position. The value of the position command of when the Y36 signal is turned ON after home position return is completed is set as the home position. The position control JOG operation can be used for the movement.
- The home position shift distance (*Pr.508* + *Pr.509*) is ignored.
- If the in-position signal (Y36) is not turned ON for 10 s after home position return is started, the home position return setting error (HP1) is displayed.



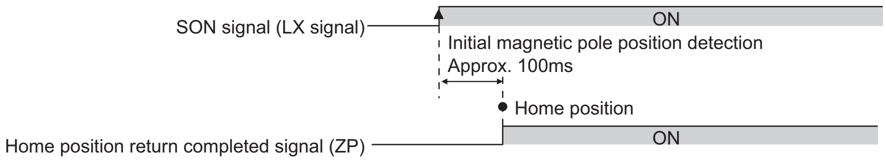
(4) Stopper type (*Pr.532* = "3", *Pr.533, Pr.534*)

- A moving part is brought into contact with the machine end stopper to determine the home position.
- Home position return is performed in the following procedure.
  1) Input the forward rotation signal (STF signal) or reverse rotation signal (STR signal) without selecting a point table or JOG operation to perform the operation according to *Pr.453 High speed during home position return*.
  2) When the moving part touches the machine end and a torque set by *Pr.533 Home position return stopper torque* or larger is applied, the OL signal is output.
  3) The condition is kept for 500 ms to establish stable press up condition.
  4) After the condition (OL signal output condition) further lasted for *Pr.534 Home position return stopper duration*, this position is determined as the machine end.
  5) The home position is calculated by shifting the machine end position in the reverse direction by the home position shift distance (*Pr.508* + *Pr.509*) at *Pr.455 Home position return shifting speed*.
- In any of the following cases, the home position return setting error (HP1) is displayed.
  ･Even after the shift from the power-ON position by 99999999 or -99999999 at the speed of *Pr.453 High speed during home position return*, the contact condition cannot be achieved.
  ･The contact condition does not last for *Pr.534 Home position return stopper duration*.
  ･In 10 s after the shift by the home position shift distance, the in-position signal (Y36) is not turned ON.



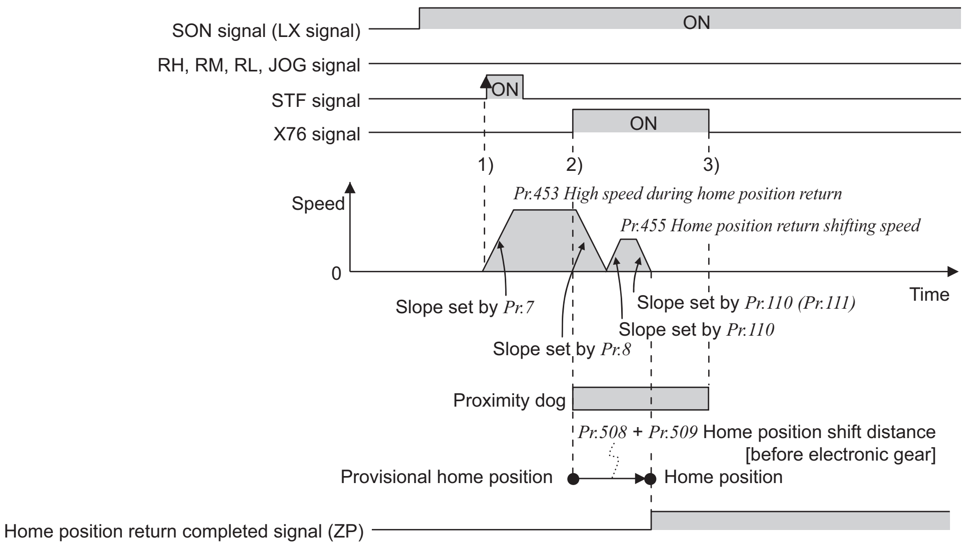
(5) Ignoring the home position (servo-ON position as the home position) (*Pr.532* = "4")

- The position at servo-ON (or pre-excitation) is set as the home position.
- The home position shift distance (*Pr.508* + *Pr.509*) is ignored.



(6) Count type with front end reference (*Pr.532* = "6")

- The home position is determined based on the detection position of the front end of the proximity dog (X76 signal). Deceleration starts at the front end of the proximity dog, and the position after the shift by the home position shift distance is set as the home position.
- To input the X76 signal, set "76" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- Home position return is performed in the following procedure.
  1) Input the forward rotation signal (STF signal) or reverse rotation signal (STR signal) without selecting a point table or JOG operation to perform the operation according to *Pr.453 High speed during home position return*.
  2) The position where the front end of the proximity dog is directed is set as the provisional home position, and the operation decelerates to stop.
  3) The position after the shift from the provisional home position by the home position shift distance is set as the home position.



- In the following conditions, the home position return setting error (HP1) is displayed.
  - ・The X76 signal is ON when shifting is started by *Pr.453*.
  - ・The X76 signal does not turn ON after the target position (99999999 or -99999999) is reached after the shifting started by *Pr.453*.
  - ・The in-position signal (ZP) does not turn ON for 10 s after the home position shift distance is reached.

NOTE

- **The home position may differ depending on the acquisition timing of the X76 signal.**

4.5.8 Setting of the electronic gear (Pr.420, Pr.421)

Set the ratio of the machine side gear and the motor side gear.

Parameter number	Name	Initial value	Setting range	Description
420	**Command pulse multiplication numerator (electronic gear numerator)**	1	1 to 32767 *1	Set the electric gear. The gear ratio range is from 1/900 to 900. *Pr.420* is a numerator and *Pr.421* is a denominator.
421	**Command pulse multiplication denominator (electronic gear denominator)**	1	1 to 32767 *1	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 With the operation panel of the drive unit, up to "9999" can be set as a setting value. With a parameter unit or FR configurator, up to the highest value in the setting range can be set.

- The position resolution (travel per pulse $\Delta \ell$ [mm]) is determined by the travel per motor revolution Δs [mm] and the number of pulses per motor rotation, and is represented by the following expression.

$$\Delta \ell = \frac{\Delta s}{Pf} = \frac{\Delta s}{5120}$$

$\Delta \ell$:travel per pulse [mm]
Δs :travel per motor rotation [mm]
Pf :number of pulses per motor rotation (= 5120) [pulse/rev]

- The position resolution (travel per pulse $\Delta \ell$ [mm]) can be changed with the electronic gear setting.

$$\Delta \ell = \frac{\Delta s}{Pf} \times \frac{Pr.420}{Pr.421}$$

$\Delta \ell$:travel per command [mm]
Δs :travel per motor rotation [mm]
Pf :number of pulses per motor rotation (= 5120) [pulse/rev]

<<Setting example>> When setting travel per pulse to 0.01mm in a machine with Δs = 10mm.

$\Delta \ell$: 0.01[mm], Δs: 10[mm], Pf: 5120[pulse/rev]

$$0.01 = \frac{10}{5120} \times \frac{Pr.420}{Pr.421} \rightarrow Pr.420 = 128,\ Pr.421 = 25$$

NOTE

- **The electronic gear setting of 1/900 or lower is limited at 1/900, and 900 or higher at 900.**

4.5.9 Setting the position adjustment parameters (Pr.426, Pr.506, Pr.507, Pr.510, Pr.511, Pr.536, Y36 signal, PBSY signal, MEND signal, CPO signal, FP signal)

Parameter number	Name	Initial value	Setting range	Description
426	**In-position width**	100 pulses	0 to 32767 pulses *1	When the number of droop pulses [after the electronic gear] falls below the setting, the in-position signal (Y36) is turned ON.
506	**Position detection hysteresis width**	0	0 to 32767 *1	Set the hysteresis width for the detection position of the position detected signal (FP signal).
507	**Rough match output range**	0	0 to 32767 *1	Set the remaining command distance [before the electronic gear] (= target position [before the electronic gear] - current position [before the electronic gear]) at which the rough match signal (CPO) is output.
510	**Position detection lower 4 digits**	0	0 to 9999	Set the lower four digits of the position detection value.
511	**Position detection upper 4 digits**	0	0 to 9999	Set the upper four digits of the position detection value.
536	**Position detection selection**	0	0	The position is detected on both the plus and minus sides.
			1	The position is detected on the plus side only.
			2	The position is detected on the minus side only.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

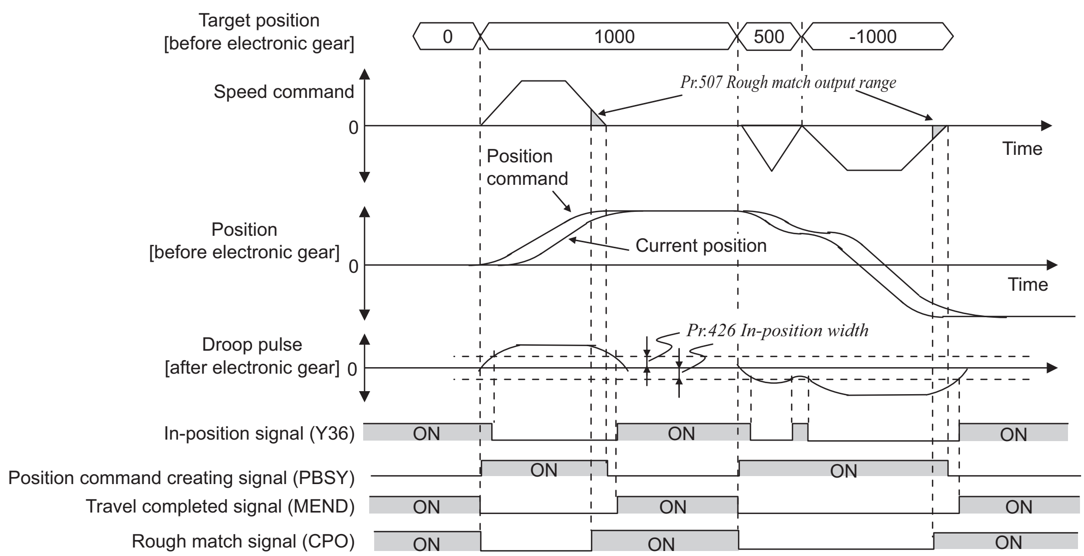
*1 With the operation panel of the drive unit, up to "9999" can be set as a setting value. With a parameter unit or FR configurator, up to the highest value in the setting range can be set.

(1) In-position width and in-position signal (*Pr.426*, Y36 signal)

- If the number of droop pulses [after the electronic gear] (= position command [after the electronic gear] - current position [after the electronic gear]) falls below the setting of *Pr.426 In-position width*, the in-position signal (Y36 signal) is turned ON. For the in-position signal (Y36 signal), assign the function by setting "36 (positive logic) or 136 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

(2) Position command creating signal (PBSY signal)

- The position command creating signal (PBSY signal) is turned ON while a position command is being created. For the terminal used for the position command creating signal (PBSY), assign the function by setting "61 (positive logic)" or "161 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.



*1 The drive unit has three output terminals at the maximum.

(3) Travel completed signal (MEND signal)

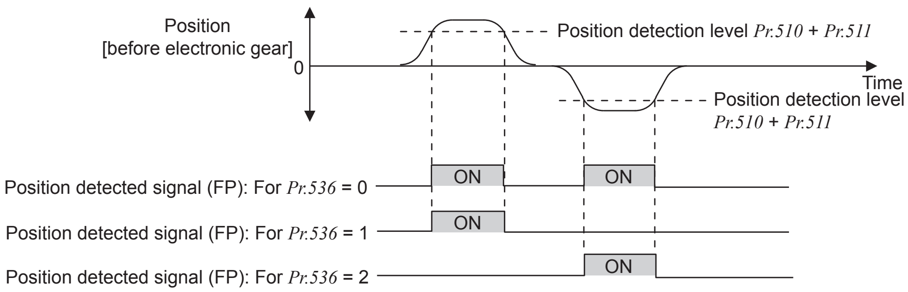
- The travel completed signal (MEND signal) is turned ON when the in-position signal (Y36) is ON and the position command creating signal (PBSY) is OFF. For the travel completed signal (MEND signal), assign the function by setting "38 (positive logic) or 138 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

(4) Rough match signal (*Pr.507*, CPO signal)

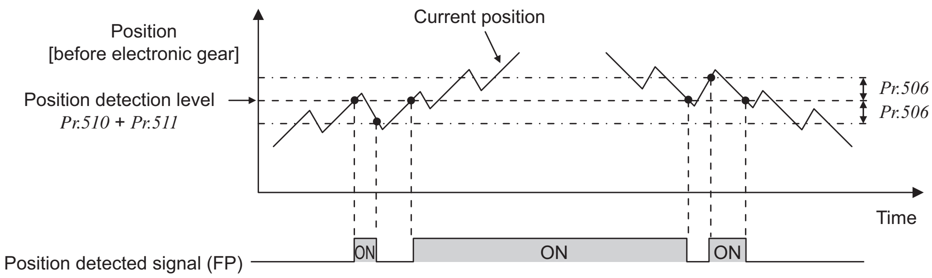
- The rough match signal is turned ON when the remaining command distance [before the electronic gear] (= target position [before the electronic gear] - current position [before the electronic gear]) falls below the setting of *Pr.507 Rough match output range*. For the rough match signal (CPO signal), assign the function by setting "55 (positive logic) or 155 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

(5) Position detected signal (*Pr.506, Pr.510, Pr.511, Pr.536*, FP signal)

- The position detected signal (FP signal) is turned ON when the current position [before the electronic gear] exceeds the position detection (*Pr.510* + *Pr.511*). For the position detected signal (FP signal), assign the function by setting "60 (positive logic) or 160 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.
- Whether the position detection is determined at a plus position or minus position can be selected by *Pr.536 Position detection selection*. When "0" is set, the position is detected on both the plus and minus sides. When "1" is set, the position is detected on the plus side only. When "2" is set, the position is detected on the minus side only.



- When a current position varies, the position detected signal may repeat ON/OFF (chatter). Setting hysteresis to the detected position prevents chattering of the signal. Use *Pr.506 Position detection hysteresis width* to set a hysteresis width.



4.6 Adjusting the output torque (current) of the motor

Purpose	Parameter to set		Refer to page
To limit the output current to avoid tripping of the drive unit	Torque limit operation	Pr.22, Pr.48, Pr.148, Pr.149, Pr.156, Pr.157	*111*
To improve the torque in low-speed range	PM control torque boost	Pr.785	*114*

4.6.1 Torque limit (Pr.22, Pr.48, Pr.148, Pr.149, Pr.156, Pr.157)

This function monitors the output current and automatically changes the rotation speed to prevent the drive unit to trip due to overcurrent.

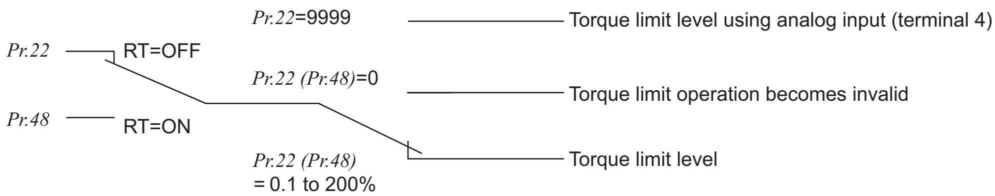
Parameter number	Name	Initial value 0.75K or lower	Initial value 1.5K or higher	Setting range	Description
22* Ver.UP	**Torque limit level**	200%	150%	0	Torque limit operation becomes invalid.
				0.1 to 200%	The current value at which torque limit operation will be started.
				9999	Torque limit level for analog input
48	**Second torque limit level**	9999		0	Torque limit operation becomes invalid.
				0.1 to 200%	The second torque limit operation level.
				9999	Same as *Pr.22*
148 Ver.UP	**Torque limit level at 0mA input**	150%		0 to 200%	The torque limit operation level can be changed by the analog signal input to the terminal 4.
149 Ver.UP	**Torque limit level at 20mA input**	200%		0 to 200%	
156	**Torque limit selection**	0		0 to 31, 100, 101	Select whether torque limit will be performed or not.
157	**OL signal output timer**	0s		0 to 25s	The output start time of the OL signal output when torque limit is activated.
				9999	Without the OL signal output

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

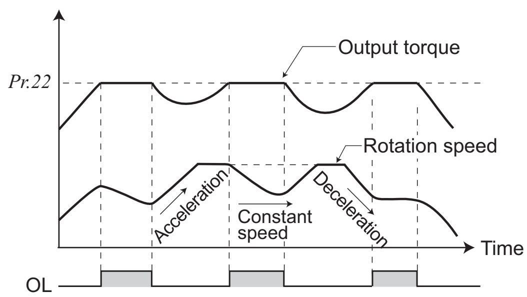
* This parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

Ver.UP ....Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

(1) Block diagram



(2) Setting the torque limit level *(Pr.22)*



Torque limit example

- If the output torque (current equivalent to the torque) exceeds the current level for the torque limit operation, the output torque is limited by adjusting the output frequency. The torque limit operation level in such a case is based on the rating torque of the motor.
- Torque limit operation stops acceleration (makes deceleration) during acceleration, makes deceleration during constant speed, and stops deceleration during deceleration.
- When torque limit operation is performed, the OL signal is output.

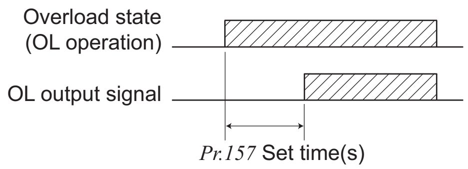
NOTE

- **If an overload status lasts long, a drive unit trip (e.g. electronic thermal relay function (E.THM)) may occur.**
- **If the speed drops to 18r/min or lower due to the torque limit operation and stays there for 3s, the fault indication (E.OLT) appears, and the drive unit outputs are shut off.**

(3) Torque limit signal output and output timing adjustment (OL signal, *Pr.157*)

- If the output torque exceeds the torque limit operation level and the torque limit operation is activated, the torque limit operation signal (OL signal) is turned ON for 100ms or longer. When the output torque drops to the torque limit operation level or lower, the output signal also turns OFF.
- Use *Pr.157 OL signal output timer* to set whether the OL signal is output immediately or after a preset period of time.
- This operation is also performed when the regeneration avoidance function oL (overvoltage stall) is executed.
- For the OL signal, set "3 (positive logic) or 103 (negative logic)" in one of *Pr.190 to Pr.192 (output terminal function selection)* to assign the function to the output terminal.

Pr.157 Setting	Description
0 (initial value)	Output immediately
0.1 to 25	Output after the set time (s) has elapsed
9999	Not output



NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

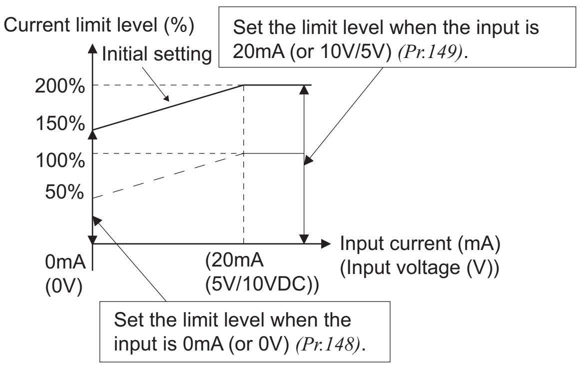
(4) Setting two torque limit levels *(Pr.48)*

- Turning ON the RT signal enables the *Pr.48 Second torque limit level*.
- To input the RT signal, set "3" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**
- **The RT signal is a second function selection signal. The RT signal also enables other second functions.** ***(Refer to page 141)***

(5) Torque limit level setting (analog variable) from terminal 4 *(Pr.148, Pr.149)* Ver.UP



- Set *Pr.22 Torque limit level* = "9999".
  Input 0 to 20 mA (or 0 to 5 V, 0 to 10 V) to the terminal 4. Use *Pr.267 Terminal 4 input selection* and the voltage/current input switch to select 5 V/10 V. The current input specification is selected in the initial setting. For how to change the setting to the voltage input, refer to *page 168*.
- Set the current limit level in *Pr.148 Torque limit level at 0mA input*.
- Set the current limit level at 20 mA (5 V/10 V) input in *Pr.149 Torque limit level at 20mA input*.

REMARKS

- When *Pr.22*="9999" (analog toque limit), the measured value input to the terminal 4 during PID control is not available.
- The AU signal is invalid.

(6) Limit the torque limit according to the operating status *(Pr.156)*

- Refer to the following table and select whether torque limit operation will be performed or not and the operation to be performed at OL signal output.

Pr.156 setting	Torque limit selection ○:Activated ●:Not activated — Speed control: Acceleration	Speed control: Constant speed	Speed control: Deceleration	Position control	OL signal output ○:Operation continued ●:Operation not continued *1
0 (initial value), 1	○	○	○	○	○
2, 3	●	○	○	○	○
4, 5	○	●	○	○	○
6, 7	●	●	○	○	○
8, 9	○	○	●	●	○
10, 11	●	○	●	●	○
12, 13	○	●	●	●	○
14, 15	●	●	●	●	— *2
16, 17	○	○	○	○	●

Pr.156 setting		Torque limit selection ○:Activated ●:Not activated — Speed control: Acceleration	Speed control: Constant speed	Speed control: Deceleration	Position control	OL signal output ○:Operation continued ●:Operation not continued *1
18, 19		●	○	○	○	●
20, 21		○	●	○	○	●
22, 23		●	●	○	○	●
24, 25		○	○	●	●	●
26, 27		●	○	●	●	●
28, 29		○	●	●	●	●
30, 31		●	●	●	●	— *2
100, 101 *3	Driving	○	○	○	○	○
	Regeneration	●	●	●	●	— *2

*1 When "Operation not continued for OL signal output" is selected, the "E.OLT" fault (stopped by torque limit) is displayed and operation stopped.

*2 Since both fast response current limit and torque limit are not activated, OL signal and E.OLT are not output.

*3 The settings "100" and "101" allow operations to be performed in the driving and regeneration modes, respectively.

NOTE

- **When the load is heavy, or when the acceleration/deceleration time is short, torque limit is activated and acceleration/deceleration may not be made according to the preset acceleration/deceleration time. Set *Pr.156* and torque limit level to the optimum values.**

CAUTION

Do not set a small value as the torque limit level. Otherwise, torque generated will reduce.

Always perform test operation.
Torque limit during acceleration may increase the acceleration time.
Torque limit performed during constant speed may cause sudden speed changes.
Torque limit during deceleration may increase the deceleration time, increasing the deceleration distance.

Parameters referred to

- *Pr.178 to Pr.184 (Input terminal function selection)* *Refer to page 138*
- *Pr.190 to Pr.192 (output terminal function selection)* *Refer to page 144*

4.6.2 Adjusting the S-PM geared motor starting torque (Pr.785) S-PM

When a S-PM geared motor is used, reduction of the motor torque in the low-speed range (lower than 300 r/min) can be improved.

Parameter number	Name	Initial value	Setting range	Description
785 Ver.UP	**PM control torque boost**	9999	0 to 150%	Set the maximum torque to be generated in the low-speed range of 300r/min or less.
			9999	Set as 100%

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
The above parameters are available with S-PM geared motors.

Ver.UP ...... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

- For *Pr. 785*, set the maximum torque to be generated in the low-speed range of 300r/min or less.
- Set a large value to generate a large starting torque.
- To operate continuously at a low speed of less than 300r/min, a current must flow regardless of load. Thus, motor overload trip (E.THM) may occur with a certain operation period even if no load is applied.
  To operate continuously at a low speed of less than 300r/min, set the following or lower values in *Pr. 785*.

Drive unit model	S-PM motor capacity	*Pr.785* setting
FR-E720EX-0.2K to 1.5K	0.1kW to 0.75kW	80% or less
FR-E720EX-2.2K, 3.7K	1.5kW, 2.2kW	50% or less

- In the low speed range of 300r/min or less, *Pr. 22 Torque limit level* is disabled. Thus, a drive unit failure, such as the overcurrent protection and the loss of synchronism detection, may occur when a torque equal to or larger than the *Pr. 785* setting is applied.

NOTE

- **Keep the short-time torque to *Pr. 785* setting or lower.**

4.7 Limiting the rotation speed

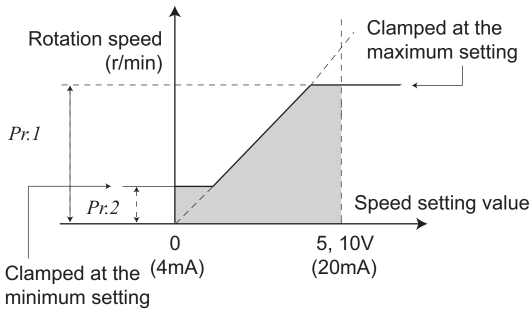
Purpose	Parameter to set		Refer to page
To set upper limit and lower limit of rotation speed	Maximum/minimum setting	Pr.1, Pr.2	115
To perform operation by avoiding mechanical resonance points	Speed jump	Pr.31 to Pr.36	116

4.7.1 Maximum/minimum setting (Pr.1, Pr.2)

You can limit the motor speed.
Clamp the upper and lower limits of the rotation speed.

Parameter number	Name	Initial value	Setting range	Description
1	**Maximum setting**	3000r/min	0 to 4800r/min *1	Upper limit of the rotation speed.
2	**Minimum setting**	0r/min	0 to 4800r/min *1	Lower limit of the rotation speed.

*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)



(1) Set maximum speed

- Use *Pr.1 Maximum setting* to set the maximum rotation speed. If the value of the speed command entered is higher than the setting, the rotation speed is clamped at the maximum speed.
- The speed command is also clamped at the operable speed range of the selected motor.
  If the motor's operable maximum speed < maximum setting, the speed does not increase to the maximum speed.

REMARKS

- Because the speed is limited by the speed command, the upper limit value or a higher value may be displayed on the monitor.

(2) Set minimum speed

- Use *Pr.2 Minimum setting* to set the minimum rotation speed.
- If the set speed is less than *Pr.2*, the rotation speed is clamped at *Pr.2* (will not fall below *Pr.2*).

REMARKS

- When *Pr.15 Jog speed setting* is equal to or less than *Pr.2*, the *Pr.15* setting has precedence over the *Pr.2* setting.
- When torque limit is activated to decrease the rotation speed, the rotation speed may drop to *Pr.2* or below.
- Because the speed is limited by the speed command, the lower limit value or a lower value may be displayed on the monitor.

NOTE

- **Under position control, the lower limit setting is disabled.**

CAUTION

Note that when *Pr.2* is set to any value equal to or more than *Pr.13 Starting speed*, simply turning ON the start signal will run the motor at the preset speed according to the set acceleration time even if the command speed is not input.

Parameters referred to

Pr.13 Starting speed Refer to page 128
Pr.15 Jog speed setting Refer to page 119
Pr.125 Terminal 2 speed setting gain speed, Pr.126 Terminal 4 speed setting gain speed Refer to page 173

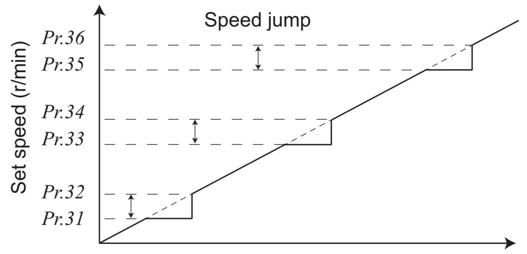
4.7.2 Avoiding mechanical resonance points (Speed jump) (Pr.31 to Pr.36)

When it is desired to avoid resonance attributable to the natural speed of a mechanical system, these parameters allow resonant speeds to be jumped.

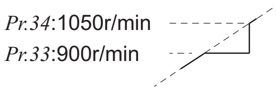
Parameter number	Name	Initial value	Setting range	Description
31	**Speed jump 1A**	9999	0 to 4800r/min *1, 9999	1A to 1B, 2A to 2B, 3A to 3B is speed jumps 9999: Function invalid
32	**Speed jump 1B**	9999	0 to 4800r/min *1, 9999	
33	**Speed jump 2A**	9999	0 to 4800r/min *1, 9999	
34	**Speed jump 2B**	9999	0 to 4800r/min *1, 9999	
35	**Speed jump 3A**	9999	0 to 4800r/min *1, 9999	
36	**Speed jump 3B**	9999	0 to 4800r/min *1, 9999	

The above parameters can be set when *Pr.160 Extended function display selection* ="0". *(Refer to page 182)*

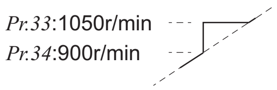
*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)



- Up to three areas may be set, with the jump speeds set to either the top or bottom point of each area.
- The settings of speed jumps 1A, 2A, 3A are jump points, and operation is performed at these speeds in the jump areas.



Example 1 To fix the speed to 900r/min in the range 900r/min to 1050r/min, set 1050r/min in *Pr.34* and 900r/min in *Pr.33*.



Example 2 To jump the speed to 1050r/min in the range 900r/min to 1050r/min, set 1050r/min in *Pr.33* and 900r/min in *Pr.34*.

NOTE

- **During acceleration/deceleration, the running speed within the set area is valid.**
- **Under position control, speed jump is disabled.**

4.8 Speed setting by external terminals

Purpose	Parameter to set		Refer to page
To make speed setting by combination of terminals	Multi-speed operation	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239	117
To perform Jog operation	Jog operation	Pr.15, Pr.16	119
To command smooth speed transition with terminals	Remote setting function	Pr.59	122

4.8.1 Operation by multi-speed operation (Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239)

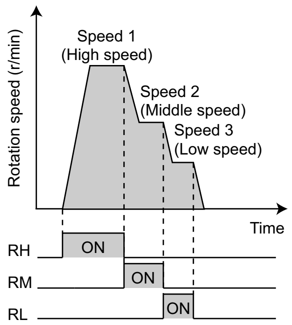
Can be used to change the preset speed in the parameter with the contact signals.
Any speed can be selected by merely turning ON/OFF the contact signals (RH, RM, RL, REX signals).

Parameter number	Name	Initial value	Setting range	Description
4	Multi-speed setting (high speed)	3000r/min	0 to 4800r/min *2	Speed when RH turns ON
5	Multi-speed setting (middle speed)	1500r/min	0 to 4800r/min *2	Speed when RM turns ON
6	Multi-speed setting (low speed)	300r/min	0 to 4800r/min *2	Speed when RL turns ON
24 *1	Multi-speed setting (speed 4)	9999	0 to 4800r/min *2, 9999	Speed from 4 speed to 15 speed can be set according to the combination of the RH, RM, RL and REX signals. 9999: not selected
25 *1	Multi-speed setting (speed 5)	9999	0 to 4800r/min *2, 9999	
26 *1	Multi-speed setting (speed 6)	9999	0 to 4800r/min *2, 9999	
27 *1	Multi-speed setting (speed 7)	9999	0 to 4800r/min *2, 9999	
232 *1	Multi-speed setting (speed 8)	9999	0 to 4800r/min *2, 9999	
233 *1	Multi-speed setting (speed 9)	9999	0 to 4800r/min *2, 9999	
234 *1	Multi-speed setting (speed 10)	9999	0 to 4800r/min *2, 9999	
235 *1	Multi-speed setting (speed 11)	9999	0 to 4800r/min *2, 9999	
236 *1	Multi-speed setting (speed 12)	9999	0 to 4800r/min *2, 9999	
237 *1	Multi-speed setting (speed 13)	9999	0 to 4800r/min *2, 9999	
238 *1	Multi-speed setting (speed 14)	9999	0 to 4800r/min *2, 9999	
239 *1	Multi-speed setting (speed 15)	9999	0 to 4800r/min *2, 9999	

The above parameters allow its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

*1 This parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*2 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)



(1) Multi-speed setting for 3 speeds *(Pr.4 to Pr.6)*

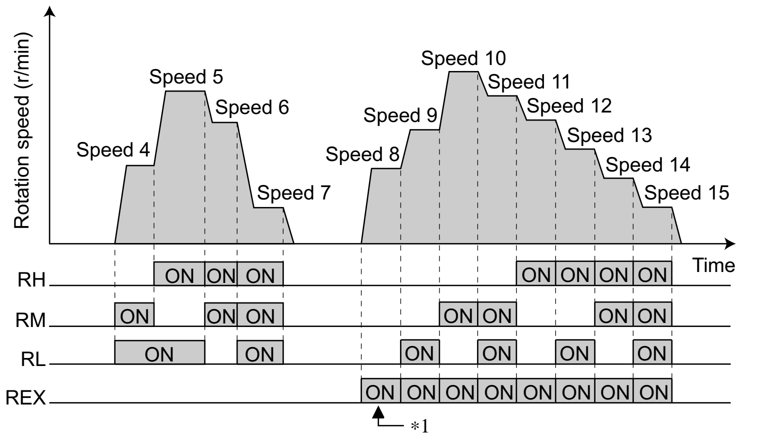
- The drive unit operates at speeds set in *Pr.4* when RH signal is ON, *Pr.5* when RM signal is ON and *Pr.6* when RL signal is ON.

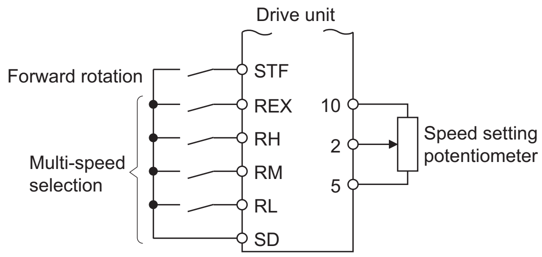
REMARKS

- In the initial setting, if two or three of multi-speed settings are simultaneously selected, priority is given to the set speed of the lower signal.
  For example, when the RH and RM signals turn ON, the RM signal *(Pr.5)* has a higher priority.
- The RH, RM, RL signals are assigned to the terminal RH, RM, RL in the initial setting. By setting "0 (RL)", "1 (RM)", "2 (RH)" in any of *Pr.178 to Pr.184 (input terminal function selection)*, you can assign the signals to other terminals.

(2) Multi-speed setting for 4 or more speeds *(Pr.24 to Pr.27, Pr.232 to Pr.239)*

- Speed from 4 speed to 15 speed can be set according to the combination of the RH, RM, RL and REX signals. Set the running speeds in *Pr.24 to Pr.27, Pr.232 to Pr.239* (In the initial value setting, speed 4 to speed 15 are invalid).
- For the terminal used for REX signal input, set "8" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.





Multi-speed operation connection example

*1 When "9999" is set in *Pr.232 Multi-speed setting (speed 8)*, operation is performed at speed set in *Pr.6* when RH, RM and RL are turned OFF and REX is turned ON.

REMARKS

- The priorities of the speed commands by the external signals are "Jog operation > multi-speed operation > terminal 4 analog input > terminal 2 analog input".
  (Refer to *page 173* for the speed command by analog input)
- Valid in the External operation mode or PU/External combined operation mode (*Pr.79* = "3" or "4").
- Multi-speed parameters can also be set in the PU or External operation mode.
- *Pr.24 to Pr.27* and *Pr.232 to Pr.239* settings have no priority between them.
- When *Pr.59 Remote function selection* ≠ "0", multi-speed setting is invalid as RH, RM and RL signals are remote setting signals.

NOTE

- **Under position control, the value in the multi-speed setting is used as the maximum speed of point tables.** ***(Refer to page 95)***
- **Changing the terminal assignment using** ***Pr.178 to Pr.184 (input terminal function selection)*** **may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.15 Jog speed setting *Refer to page 119*
Pr.59 Remote function selection *Refer to page 122*
Pr.79 Operation mode selection *Refer to page 186*
Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*

4.8.2 Jog operation (Pr.15, Pr.16, JOG signal, JOG2 signal)

You can set the speed and acceleration/deceleration time for Jog operation.
This operation can be used for conveyor positioning, test operation, etc.

Parameter number	Name	Initial value	Setting range	Description
15 *1	**Jog speed setting**	150r/min	0 to 4800r/min *2	Speed for Jog operation.
16 *1	**Jog acceleration/ deceleration time**	0.5s	0 to 360s	Acceleration/deceleration time for Jog operation. As the acceleration/ deceleration time, set the time taken to reach the speed (initial value is 3000r/min) set in *Pr.20 Acceleration/deceleration reference speed*. Acceleration/deceleration time can not be set separately.

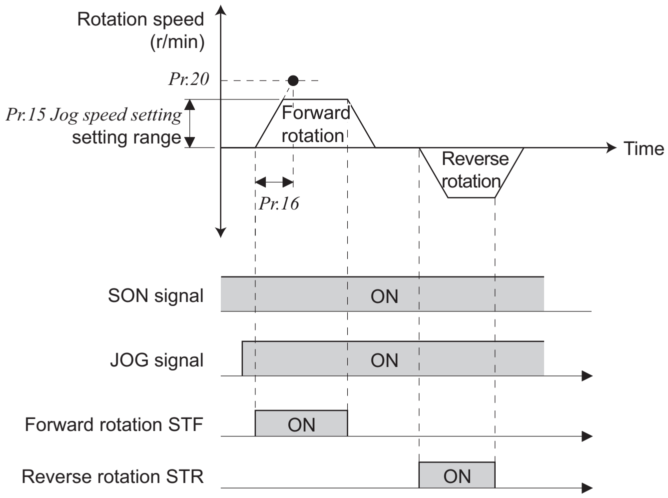
These parameters are displayed as simple mode parameter only when the parameter unit (FR-PU07) is connected. When the parameter unit is not connected, the above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

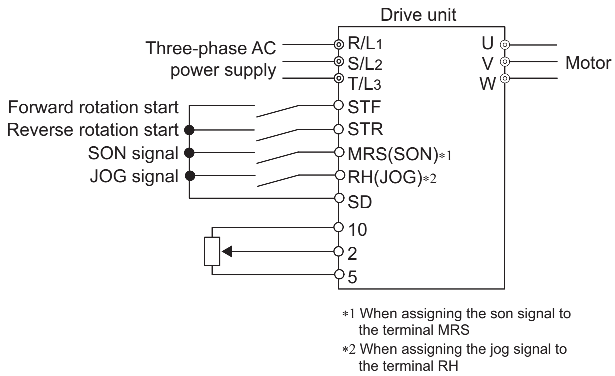
*1 The setting value change during the JOG operation is not applied. The setting value is applied when the JOG operation is stopped.

*2 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

(1) JOG operation under position control

- To perform position control, turn ON the SON signal or the LX signal. For the description of the SON signal and the LX signal, refer to *page 131*.
  To input the SON signal, set "86" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
  To input the LX signal, set "23" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal.
- The JOG operation under position control does not require home position return. If no home position return is performed, the position at which the SON signal (LX signal) is turned ON is set as the home position.
- The operation range of the JOG operation is within the command data setting range (-99999999 to 99999999). When the target position is set out of the range, the operation stops with the target position of 99999999 (for plus) or -99999999 (for minus).

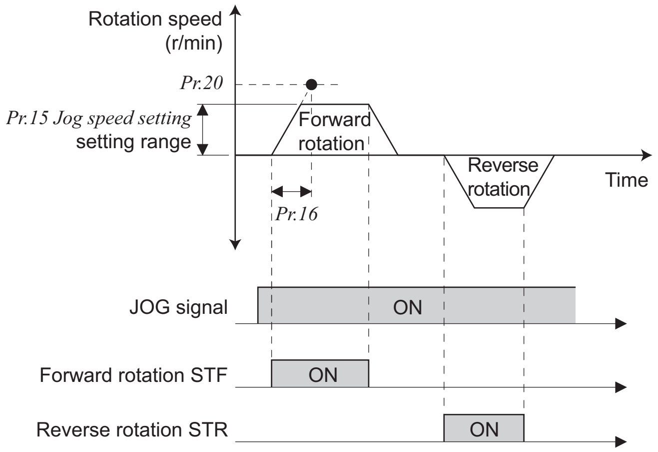


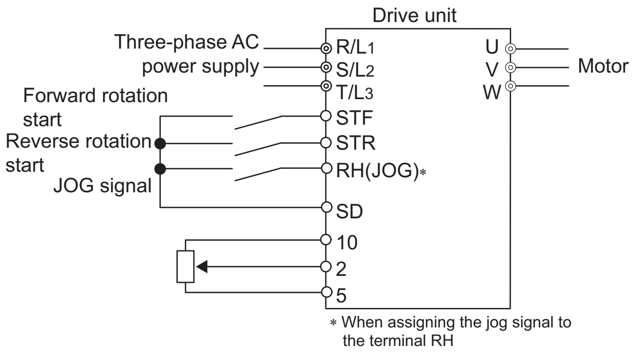


Connection diagram for external Jog operation

(2) Jog operation from outside

- When the JOG (JOG2) signal is ON, a start and stop can be made by the start signal (STF, STR).
- For the terminal used for Jog operation selection, set "5" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.
- To perform JOG operation via a network such as CC-Link, use the JOG2 signal.
  To use JOG operation selection 2, set "30" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function to a terminal. *(Refer to page 138)*





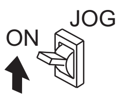
Connection diagram for external Jog operation

Operation — **Display**

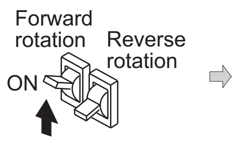
1. Screen at power-ON
   - Confirm that the External operation mode is selected. ([EXT] lit)

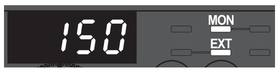
     If not displayed, press PU/EXT to change to the External (EXT) operation mode. If the operation mode still does not change, set *Pr.79* to change to the External operation mode.

2. Turn ON the JOG switch.



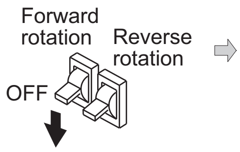
3. Turn the start switch (STF or STR) ON.
   - The motor runs while the start switch (STF or STR) is ON.
   - The motor runs at 150r/min. (initial value of *Pr.15*)

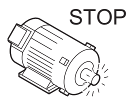




Rotates while ON

4. Turn the start switch (STF or STR) OFF.



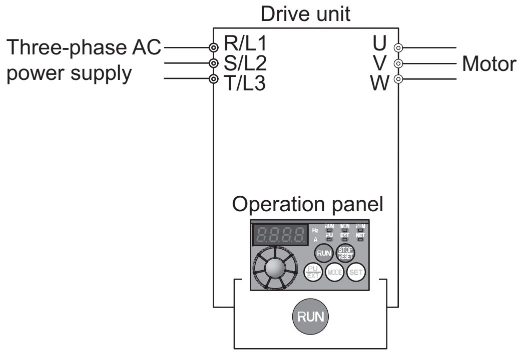


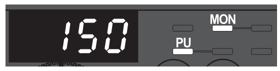
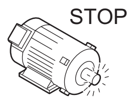
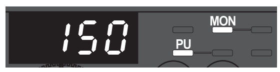
REMARKS

- When you want to change the running speed, change *Pr.15 Jog speed setting*. (initial value "150r/min")
- When you want to change the acceleration/deceleration time, change *Pr.16 Jog acceleration/deceleration time*. (initial value "0.5s") The acceleration time and deceleration time cannot be set separately for Jog operation.

(3) Jog operation from PU

- Enable the JOG operation mode using the operation panel and PU (FR-PU07) under speed control. Operation is performed only while the start button is pressed.



Operation		Display
1. Confirmation of the operation status indicator and operation mode indicator ● The monitor mode should have been selected. ● The drive unit should be at a stop.		
2. Press (PU/EXT) to choose the PU Jog operation mode.	(PU/EXT) ⇨	
3. Press (RUN). ● While (RUN) is pressed, the motor rotates. ● The motor runs at 150r/min. (*Pr.15* initial value)	(RUN) Hold down. ⇨	
4. Release (RUN)	(RUN) Release ⇨	
[When changing the speed of PU Jog operation]		
5. Press (MODE) to choose the parameter setting mode.	(MODE) ⇨	PRM indicator is lit. (The parameter number read previously appears.)
6. Turn the setting dial until *Pr.15 Jog speed setting* appears.	⇨	
7. Press (SET) to show the currently set value. (150r/min)	(SET) ⇨	
8. Turn the setting dial to set the value to "300". (300r/min)	⇨	
9. Press (SET) to set.	(SET) ⇨	**Flicker...Parameter setting complete!!**
10. Perform the operations in steps 1 to 4. The motor rotates at 300r/min.		

4

PARAMETERS

NOTE

- **The *Pr.15* setting should be equal to or higher than the *Pr.13 Starting speed*. If "0r/min" is set in *Pr.15* under position control, no position command is created and the stop state remains.**
- **The JOG signal (JOG2 signal) can be assigned to the input terminal using any of *Pr.178 to Pr.184 (input terminal function selection)*. When terminal assignment is changed, the other functions may be affected. Set parameters after confirming the function of each terminal.**
- **During Jog operation, the second acceleration/deceleration via the RT signal cannot be selected. (The other second functions are valid. *(Refer to page 141)*)**
- **When *Pr.79 Operation mode selection* = "4", pressing RUN of the operation panel and FWD / REV of the parameter unit (FR-PU07) starts the drive unit and pressing STOP RESET stops the drive unit.**
- **This function is invalid when *Pr.79* = "3".**

Parameters referred to

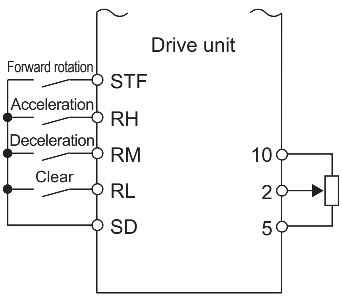
- *Pr.29 Acceleration/deceleration pattern selection* *Refer to page 129*
- *Pr.20 Acceleration/deceleration reference speed* *Refer to page 125*
- *Pr.79 Operation mode selection* *Refer to page 186*
- *Pr.178 to Pr.184 (input terminal function selection)* *Refer to page 138*

4.8.3 Remote setting function (Pr.59)

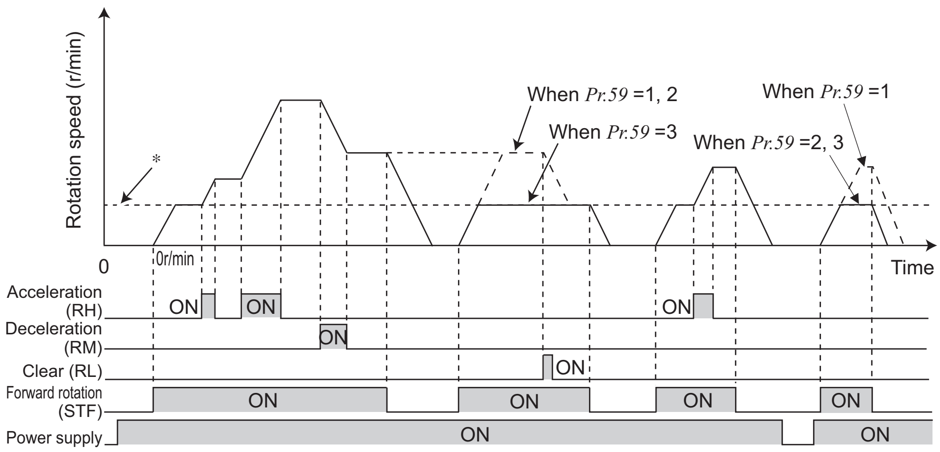
- Even if the operation panel is located away from the enclosure, you can use contact signals to perform continuous variable-speed operation, without using analog signals.
- By merely setting this parameter, you can use the acceleration, deceleration and setting clear functions of the motorized speed setter (FR-FK).

Parameter number	Name	Initial value	Setting range	Description: RH, RM, RL signal function	Description: Speed setting storage function
59	Remote function selection	0	0	Multi-speed setting	—
			1	Remote setting	With
			2	Remote setting	Not used (Turning the power OFF clears remotely-set speed.)
			3	Remote setting	Not used (Turning the power OFF or STF/STR OFF clears remotely-set speed.)

The above parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*



Connection diagram for remote setting



* External running speed (other than multi-speed) or PU running speed

(1) Remote setting function

- Use *Pr.59* to select whether the remote setting function is used or not and whether the speed setting storage function in the remote setting mode is used or not.
  When *Pr.59* is set to any of "1 to 3" (remote setting function valid), the functions of the RH, RM and RL signals are changed to acceleration (RH), deceleration (RM) and clear (RL).
- When using the remote setting function, following speeds can be compensated to the speed set by RH and RM operation according to the operation mode.
  During external operation (including *Pr.79* = "4")................................... external speed command other than multi-speed settings
  During external operation and PU combined operation (*Pr.79* = "3") ..... PU speed command or terminal 4 input
  During PU operation.. PU speed command

(2) Speed setting storage

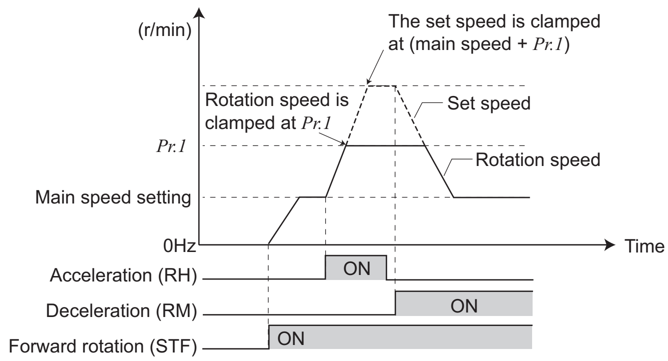
- The speed setting storage function stores the remotely-set speed (speed set by RH/RM operation) into the memory (EEPROM). When power is switched OFF once, then ON, operation is resumed with that rotation speed value. (*Pr.59* = 1)

<Speed setting storage conditions>

- When the start signal (STF or STR) turns OFF.
- Every minute after both the RH (acceleration) and RM (deceleration) signals turn OFF (ON). (The speed is overwritten if the latest speed is different from the previous speed when comparing the two. The state of the RL signal does not affect writing.)

NOTE

- **The range of speed changeable by RH (acceleration) and RM (deceleration) is 0 to maximum speed (*Pr.1* setting). Note that the maximum value of set speed is (main speed + maximum speed).**



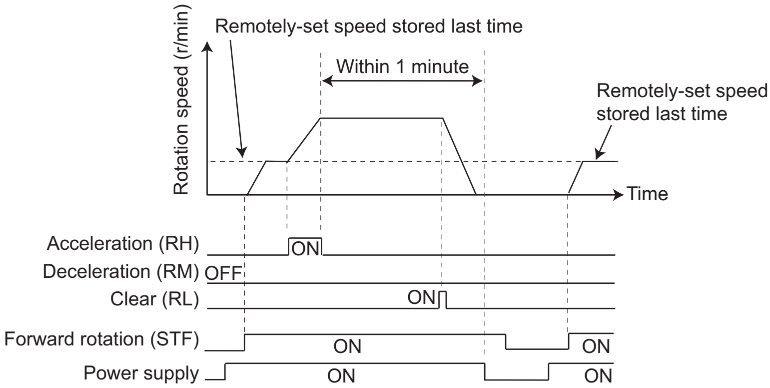
- **When the acceleration or deceleration signal switches ON, acceleration/deceleration time is as set in *Pr.44 Second acceleration/deceleration time* and *Pr.45 Second deceleration time*. Note that when the time set in *Pr.7* or *Pr.8* is longer than the time set in *Pr.44* or *Pr.45*, the acceleration/deceleration time is as set in *Pr.7* or *Pr.8*. (when RT signal is OFF)**
  When the RT signal is ON, acceleration/deceleration is made in the time set in *Pr.44* and *Pr.45*, regardless of the *Pr.7* or *Pr.8* setting.
- **Even if the start signal (STF or STR) is OFF, turning ON the acceleration (RH) or deceleration (RM) signal varies the preset frequency. (*Pr.59* = "1, 2")**
- **When switching the start signal from ON to OFF, or changing speed by the RH or RM signal speed, set the speed setting value storage function (write to EEPROM) invalid (*Pr.59* = "2, 3"). If set valid (*Pr.59* = "1"), speed is written to EEPROM speed, this will shorten the life of the EEPROM.**
- **The RH, RM, RL signals can be assigned to the input terminal using any *Pr.178 to Pr.184 (input terminal function selection)*. When terminal assignment is changed, the other functions may be affected. Set parameters after confirming the function of each terminal.**
- **Also available for the Network operation mode.**
- **Under position control, the remote setting function is disabled.**

REMARKS

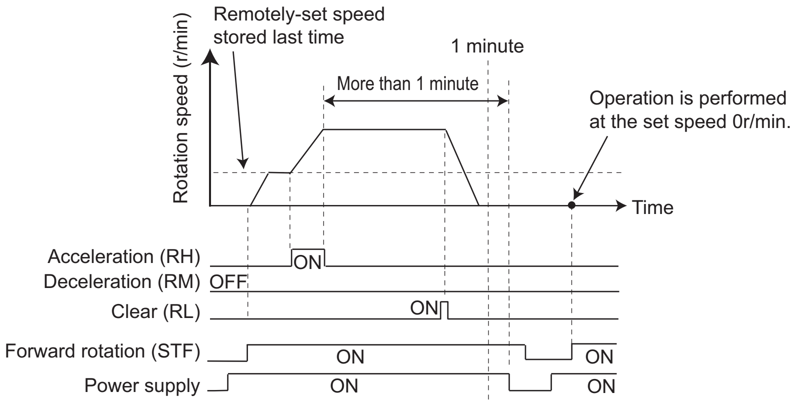
During Jog operation or PID control operation, the remote setting function is invalid.

Setting speed is "0"

- Even when the remotely-set speed is cleared by turning ON the RL (clear) signal after turn OFF (ON) of both the RH and RM signals, the drive unit operates at the remotely-set speed stored in the last operation if power is reapplied before one minute has elapsed since turn OFF (ON) of both the RH and RM signals



- When the remotely-set speed is cleared by turning ON the RL (clear) signal after turn OFF (ON) of both the RH and RM signals, the drive unit operates at the speed in the remotely-set speed cleared state if power is reapplied after one minute has elapsed since turn OFF (ON) of both the RH and RM signals.



CAUTION

When selecting this function, re-set the maximum speed according to the machine.

Parameters referred to

Pr.1 Maximum setting *Refer to page 115*

Pr.7 Acceleration time, Pr.8 Deceleration time, Pr.44 Second acceleration/deceleration time, Pr.45 Second deceleration time *Refer to page 125*

Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*

4.9 Setting of acceleration/deceleration time and acceleration/deceleration pattern

Purpose	Parameter to set		Refer to page
To set motor acceleration/ deceleration time	Acceleration/deceleration times	Pr.7, Pr.8, Pr.20, Pr.44, Pr.45, Pr.147, Pr.375, Pr.791, Pr.792	125
To set starting speed	Starting speed	Pr.13	128
To set acceleration/deceleration pattern suitable for application	Acceleration/deceleration pattern	Pr.29	129

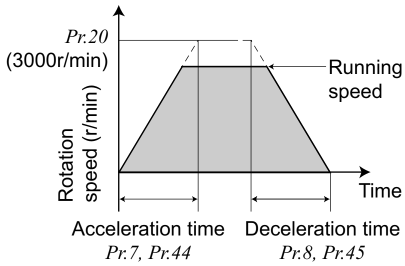
4.9.1 Setting of the acceleration and deceleration time (Pr.7, Pr.8, Pr.20, Pr.44, Pr.45, Pr.147, Pr.375, Pr.791, Pr.792)

Used to set motor acceleration/deceleration time.
Set a larger value for a slower speed increase/decrease or a smaller value for a faster speed increase/decrease.

Parameter number	Name	Initial value	Setting range	Description
7	Acceleration time	5s	0 to 360s	Motor acceleration time.
8	Deceleration time	5s	0 to 360s	Motor deceleration time.
20 *1	Acceleration/deceleration reference speed	3000r/min	12 to 4800r/min *2	Speed that will be the basis of acceleration/ deceleration time. As acceleration/deceleration time, set the frequency change time from stop to *Pr.20*.
44 *1	Second acceleration/ deceleration time	5s	0 to 360s	Acceleration/deceleration time when the RT signal is ON.
45 *1	Second deceleration time	9999	0 to 360s	Deceleration time when the RT signal is ON.
			9999	Acceleration time = deceleration time
147 *1	Acceleration/deceleration time switching speed	9999	0 to 4800r/min *2	Speed when automatically switching to the acceleration/deceleration time of *Pr.44* and *Pr.45*.
			9999	No function
375	Faulty acceleration rate detection level	9999	0 to 4800r/min/ms *2	When the acceleration rate of the motor rotation speed has exceeded the set value, the acceleration rate error (E.OA) occurs.
			9999	Faulty acceleration rate detection is disabled.
791	Acceleration time in low-speed range	9999	0 to 3600s	Acceleration time in the low-speed range (300r/ min or lower*3)
			9999	The *Pr.7* setting is used as the acceleration time.
792	Deceleration time in low-speed range	9999	0 to 3600s	Deceleration time in the low-speed range (300r/ min or lower*3)
			9999	The *Pr.8* setting is used as the deceleration time.

*1 The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
*2 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)
*3 600 r/min or lower when an MM-GKR13 motor is driven.

(1) Acceleration time setting *(Pr.7, Pr.20)*



- Use *Pr.7 Acceleration time* to set the acceleration time required to reach *Pr.20 Acceleration/deceleration reference speed* from 0r/min.
- Set the acceleration time according to the following formula.

$$\text{Acceleration time setting} = \frac{Pr.20}{\text{Maximum operating speed}} \times \text{Acceleration time from a stop to the maximum operating speed}$$

Example) How to find the setting value for *Pr.7* when increasing the rotation speed to the maximum speed of 2500r/min in 10s with *Pr.20* = 3000r/min (initial setting)

$$Pr.7 = \frac{3000\text{r/min}}{2500\text{r/min}} \times 10\text{s} = 12\text{s}$$

(2) Deceleration time setting *(Pr.8, Pr.20)*

- Use *Pr.8 Deceleration time* to set the deceleration time required to reach 0r/min from *Pr.20 Acceleration/deceleration reference speed*.
- Set the deceleration time according to the following expression.

$$\text{Deceleration time setting} = \frac{Pr.20}{\text{Maximum operating speed} - Pr.10^{*}} \times \text{Deceleration time from the maximum operating speed to a stop}$$

* For *Pr.11* = "0". When *Pr.11* ≠ "0", "-*Pr.10*" is not required.

Example) How to find the setting value for *Pr.8* when decreasing the rotation speed from the maximum speed of 2500r/min in 10s with *Pr.20* = 3000r/min, *Pr.10* = 90r/min (initial setting) and *Pr.11* = 0.

$$Pr.8 = \frac{3000\text{r/min}}{2500\text{r/min} - 90\text{r/min}} \times 10\text{s} \fallingdotseq 12.5\text{s}$$

REMARKS

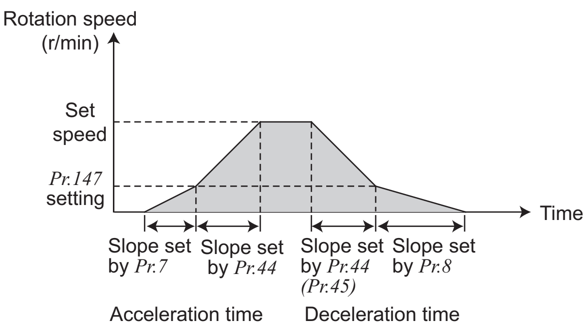
- If the protective function (E.OLT) is activated due to insufficient torque in the low-speed range, set longer acceleration/ deceleration times in the low-speed range only by *Pr.791 Acceleration time in low-speed range* and *Pr.792 Deceleration time in low-speed range*.

(3) Set two kinds of acceleration/deceleration times (RT signal, *Pr.44, Pr.45, Pr.147*)

- *Pr.44* and *Pr.45* are valid when the RT signal is ON, or the rotation speed reaches or exceeds the setting of *Pr.147*.
- When "9999" is set to *Pr.45*, the deceleration time becomes equal to the acceleration time *(Pr.44)*.
- For the RT signal, set "3" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.
- Acceleration/deceleration time changes when the RT signal turns ON or the rotation speed reaches the *Pr.147* setting or higher.

Pr.147 Setting	Acceleration/Deceleration Time	Description
9999 (initial value)	*Pr.7, Pr.8*	No automatic switching of the acceleration/deceleration time
0r/min	*Pr.44, Pr.45*	Second acceleration/deceleration time from a start
1r/min ≤ *Pr.147* ≤ Set speed	Rotation speed < *Pr.147*: *Pr.7, Pr.8* *Pr.147* ≤ rotation speed: *Pr.44, Pr.45*	Acceleration/deceleration time automatic switching *
Set speed < *Pr.147*	*Pr.7, Pr.8*	No automatic switching, since speed will not reach the switching speed

* When the RT signal turns on, the acceleration/deceleration time switches to the second acceleration/deceleration time even when the speed is not reached to *Pr.147* setting.

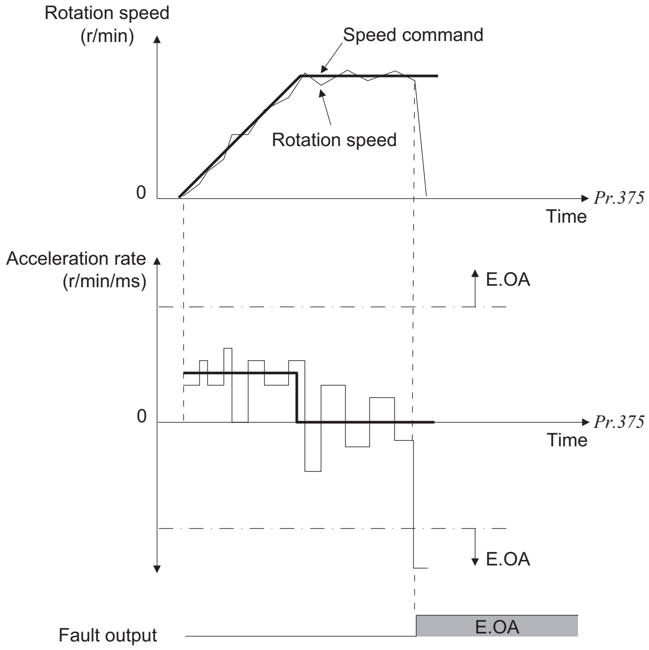


NOTE

- **Changing terminal assignment may affect the other functions. Set parameters after confirming the function of each terminal.**

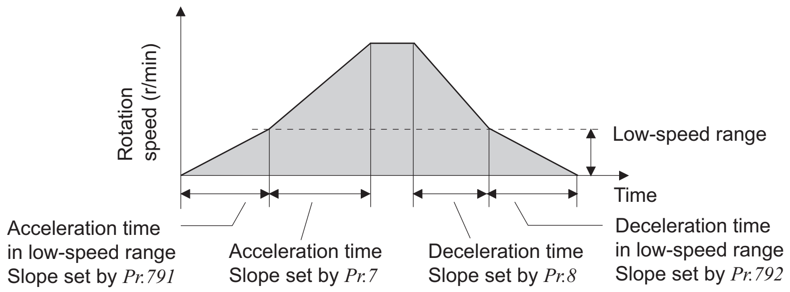
(4) Faulty acceleration rate detection *(Pr.375)*

- When the acceleration rate of the motor rotation speed is increased, such as when the machine collides against a foreign object, the drive unit can cause the acceleration rate error (E.OA) to trip. The rotation speed calculated inside the drive unit is used as the motor rotation speed.
- Set *Pr.375 Faulty acceleration rate detection level* much larger than the acceleration/deceleration slope. If the setting of *Pr.375 Faulty acceleration rate detection level* is lower than the acceleration/deceleration slope, the acceleration rate error (E.OA) occurs even during normal operation.
- If rapid acceleration/deceleration is set for normal operation and the acceleration rate error (E.OA) occurs, the acceleration rate error detection cannot be used. Set *Pr.375* = "9999" to disable the acceleration rate error detection.



(5) Setting the acceleration/deceleration time in the low-speed range *(Pr.791, Pr.792)*

- If torque is required in a low-speed range at 300 r/min or lower (600 r/min or lower for driving MM-GKR13), set *Pr.791 Acceleration time in low-speed range* and *Pr.792 Deceleration time in low-speed range* settings higher than the *Pr.7 Acceleration time* and *Pr.8 Deceleration time* settings so that the mild acceleration/deceleration is performed only in the low-speed range.
- If torque is required in the low-speed range (600r/min or less), set *Pr.791 Acceleration time in low-speed range* and *Pr.792 Deceleration time in low-speed range* settings higher than the *Pr.7 Acceleration time* and *Pr.8 Deceleration time* settings so that the mild acceleration/deceleration is performed in the low-speed range.
- Set the time for the acceleration from a stop to *Pr.20 Acceleration/deceleration reference speed* as the acceleration time. Set the time for the deceleration from *Pr.20 Acceleration/deceleration reference speed* to a stop as the deceleration time.



REMARKS

- The RT signal acts as the second function selection signal and makes the other second function valid. *(Refer to page 141)*)
- If the *Pr.20* setting is changed, the *Pr.125* and *Pr.126 (speed setting signal gain speed)* settings do not change. Set *Pr.125* and *Pr.126* to adjust the gains.
- Set *Pr.791* higher than *Pr.7*, and *Pr.792* higher than *Pr.8*. If set as *Pr.791* < *Pr.7*, the operation is performed as *Pr.791* = *Pr.7*. If set as *Pr.792* < *Pr.8*, the operation is performed as *Pr.792* = *Pr.8*.
- If the acceleration/deceleration time is set, the actual motor acceleration/deceleration time cannot be made shorter than the shortest acceleration/deceleration time determined by the mechanical system J (moment of inertia) and motor torque.

NOTE

- **Under position control, *Pr.7, Pr.8, Pr.44, Pr.45, Pr.147, Pr.791, and Pr.792* are invalid.** *(Refer to page 88)*

Parameters referred to

Pr.10 Coasting speed *Refer to page 131*
Pr.29 Acceleration/deceleration pattern selection *Refer to page 129*
Pr.125, Pr.126 (speed setting gain speed) *Refer to page 173*
Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*

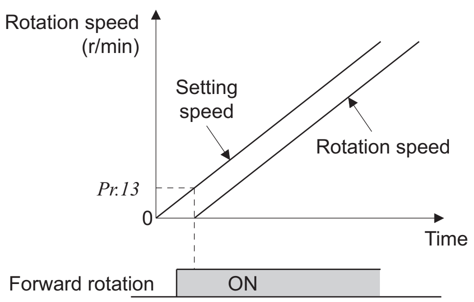
4.9.2 Motor starting speed (Pr.13)

The speed at which the motor starts running can be set.
Set the deadband in the low-speed range to eliminate noise and offset deviation when setting a speed with analog input.

Parameter number	Name	Initial value	Setting range	Description
13	**Starting speed**	15r/min	0 to 4800r/min ∗1	The speed where the motor starts running.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

∗1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)



- The speed where the PM motor starts running can be set.
- While the speed command is less than the *Pr.13 Starting speed* setting, the motor is stopped when a start command (forward or reverse) is input.
  When the speed command reaches the setting value or higher, the PM motor accelerates according to the *Pr.7 Acceleration time* setting.

NOTE

- **Under position control, the starting speed is invalid.**
- **When an MM-GKR motor is used, the operation for stopping (zero speed control or servo lock) can be selected in *Pr.802 Pre-excitation selection (brake operation selection)*.**
  When an S-PM geared motor is used, the DC injection brake operation is applied.

CAUTION

Note that when *Pr.13* is set to any value equal to or lower than *Pr.2 Minimum setting*, simply turning ON the start signal will run the motor at the preset speed even if the command speed is not input.

Parameters referred to

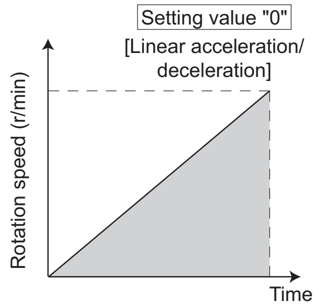
Pr.2 Minimum setting *Refer to page 115*
Pr.7 Acceleration time *Refer to page 125*
Pr.802 Pre-excitation selection (brake operation selection) *Refer to page 131*

4.9.3 Acceleration/deceleration pattern (Pr.29)

You can set the acceleration/deceleration pattern suitable for application.

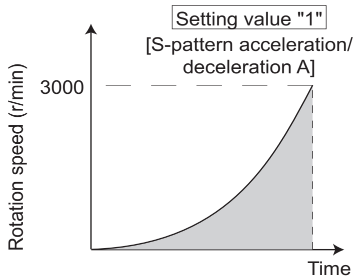
Parameter number	Name	Initial value	Setting range	Description
29	Acceleration/deceleration pattern selection	0	0	Linear acceleration/ deceleration
			1	S-pattern acceleration/deceleration A
			2	S-pattern acceleration/deceleration B

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*



(1) Linear acceleration/deceleration (*Pr.29* = "0", initial value)

- For the drive unit operation, the speed is made to change linearly (linear acceleration/deceleration) to prevent the motor and drive unit from excessive stress to reach the set speed during acceleration, deceleration, etc. when speed changes. Linear acceleration/deceleration has a uniform speed/time slope.

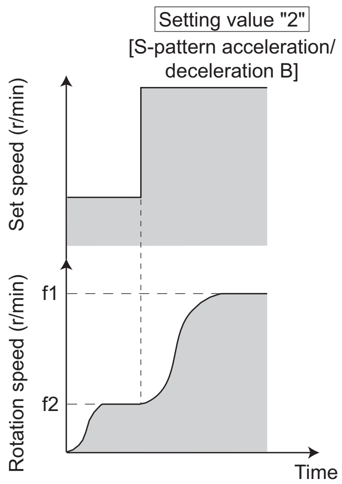


(2) S-pattern acceleration/deceleration A (*Pr.29* = "1")

- An acceleration/deceleration pattern in which the rated motor speed (3000r/min) is the point of inflection in an S-pattern curve.

NOTE

- **As the acceleration/deceleration time of S-pattern acceleration/deceleration A, set the time taken until motor rated speed is reached, not *Pr.20 Acceleration/deceleration reference speed*.**



(3) S-pattern acceleration/deceleration B (*Pr.29* = "2")

- For prevention of load shifting in conveyor and other applications.
  Since acceleration/deceleration is always made in an S shape from current speed (f2) to target speed (f1), this function eases shock produced at acceleration/deceleration and is effective for load collapse prevention, etc.

NOTE

- **Under position control, the acceleration/deceleration pattern selection is disabled. (The linear acceleration/ deceleration is always applied.)**

Parameter referred to

Pr.7 Acceleration time, Pr.8 Deceleration time, Pr.20 Acceleration/deceleration reference speed *Refer to page 125*

4.10 Selection and protection of a motor

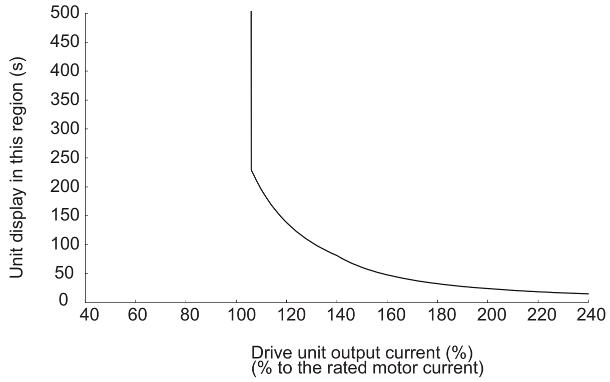
4.10.1 Motor overheat protection (Electronic thermal O/L relay) (Pr.9)

Set the current of the electronic thermal relay function to protect the motor from overheat. This feature provides the optimum protective characteristics, including reduced motor cooling capability, at low speed.

Parameter number	Name	Initial value	Setting range	Description
9	**Electronic thermal O/L relay**	Motor rated current *	0 to 500A	Set the rated motor current.

* Refer to *page 307* for the rated motor current.

(1) Electronic thermal O/L relay *(Pr.9)*



This function detects the overload (overheat) of the motor and trips. (The operation characteristic is shown on the left)

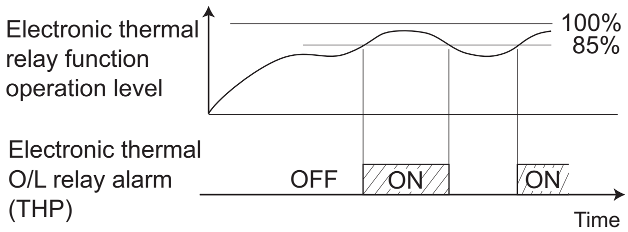
- Set the rated current (A) of the motor in *Pr.9*.
- Set "0" in *Pr.9* when you do not want to operate the electronic thermal O/L relay, e.g. when using an external thermal relay with the motor. (Note that the output transistor protection of the drive unit functions (E.THT).)

NOTE

- **The internal accumulated heat value of the electronic thermal relay function is reset by the drive unit's power reset or a reset signal input. Avoid unnecessary resets and power-OFF.**

(2) Electronic thermal relay function prealarm (TH) and alarm signal (THP signal)

100%: Electronic thermal O/L relay alarm operation value

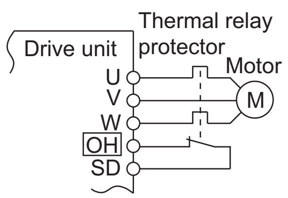


- The alarm signal (THP) is output and electronic thermal relay function prealarm (TH) is displayed when the electronic thermal O/L relay cumulative value reaches 85% of the level set in *Pr.9*. If it reaches 100% of the *Pr.9 Electronic thermal O/L relay* setting, a motor overload trip (E.THM/E.THT) occurs.
- The drive unit does not trip even when the alarm signal (THP) is output.
- For the terminal used for the THP signal output, assign the function by setting "8 (positive logic) or 108 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

(3) External thermal relay input (OH signal)



External thermal relay input connection example

- To protect the motor against overheat, use the OH signal when using an external thermal relay.
- When the thermal relay operates, the drive unit trips and outputs the fault signal (E.OHT).
- For the terminal used for OH signal input, assign the function by setting "7" to any of *Pr.178 to Pr.184 (input terminal function selection)*.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.178 to Pr.184 (input terminal function selection) ☞ *Refer to page 138*
Pr.190 to Pr.192 (output terminal function selection) ☞ *Refer to page 144*

4.11 Motor brake and stop operation

Purpose	Parameter to set		Refer to page
To adjust the braking operation	DC injection brake, zero speed control, servo lock	Pr.10, Pr.11, Pr.795, Pr.802	*131*
To activate the electromagnetic brake by the output signal	Electromagnetic brake interlock	Pr.736	*135*
To improve the motor braking torque with an option	Selection of a regenerative brake	Pr.30, Pr.70	*136*
To coast the motor to a stop	Selection of motor stopping method	Pr.10, Pr.11, Pr.250	*137*

4.11.1 *Zero speed control, pre-excitation, servo-ON, and servo lock (Pr.10, Pr.11, Pr.795, Pr.802, LX signal, SON signal)*

Zero speed control is performed and applies braking torque to stop the motor.

Parameter number	Name	Initial value	Setting range	Description
10	**Coasting speed**	90r/min	0 to 4800r/min *1	The speed where the motor starts coasting
11	**DC injection brake operation time**	0.5s	0	Injection brake control disabled
			0.1 to 10s	Operation time of injection brake control
795*2 Ver.UP	**DC brake torque boost**	9999	0 to 150%	Maximum torque that can be generated during DC injection brake (pre-excitation) operation
			9999	50% setting
802*3	**Pre-excitation selection (brake operation selection)**	0	0	Zero speed control
			1	Servo lock

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

*2 This parameter is available with S-PM geared motors.

*3 This parameter is available with MM-GKR motors.

Ver.UP ...... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

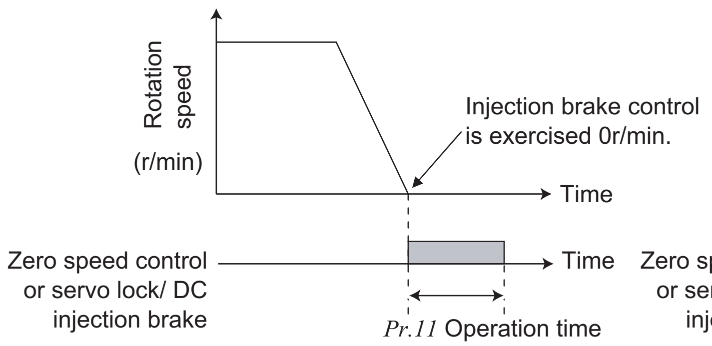
(1) Operation speed setting *(Pr.10)*

- When the speed at which coasting starts is set in *Pr.10*, output is shutoff when this speed is reached during deceleration and motor starts coasting.
- When *Pr.11* ≠ "0", *Pr.10* is always set to 0r/min.

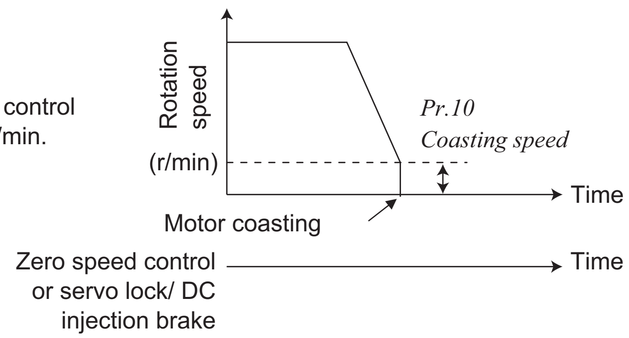
(2) Operation time setting *(Pr.11)*

- In *Pr.11*, set the time of DC injection brake control.
- When the motor does not stop due to large load moment (J), increasing the setting produces an effect.
- When *Pr.11* = "0s", DC injection brake control is disabled. (At a stop, the motor coasts.)

Operation example with injection brake control enabled (*Pr.11* ≠"0")



Operation example with injection brake control disabled (*Pr.11* = "0s")



(3) Torque setting during DC injection brake operation *(Pr.795)* S-PM

- In *Pr.795*, set the maximum torque that can be generated during DC injection brake operation.
- When a value exceeding 50% is set, motor overload trip (E.THM) may occur depending on the DC injection brake (pre-excitation) operation time.

(4) Servo-ON signal (SON signal)

- Turning ON the SON signal turns ON the base circuit to set the drive unit ready for operation (servo-ON status). Turning OFF the SON signal turns OFF the base circuit to cause the motor to coast.
- Turning ON the SON signal activates zero speed control, servo lock or DC injection brake while the motor is stopped. (Initial magnetic pole detection is performed if the SON signal is turned from OFF to ON during a stop.)
- When the SON signal is assigned to an input terminal, the SON signal must be ON to accept the start signal (STF or STR signal). Additionally, when the SON signal is assigned to an input terminal, the pre-excitation signal (LX signal) is invalid.
- The SON signal is valid in all the operation modes. For example, even in the PU operation mode, the operation cannot be started with the SON signal OFF.
- To assign the SON signal, set "86" in any of *Pr.178 to Pr.184 (input terminal function selection)*.
- When the operation becomes ready by turning ON the SON signal, the operation ready 2 signal (RY2) is turned ON. The output shutoff signal (MRS signal) is OFF.
  For the operation ready 2 signal (RY2), assign the function by setting "33 (positive logic) or 133 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

(5) Pre-excitation signal (LX signal)

- Turning ON the LX signal activates zero speed control, servo lock or DC injection brake while the motor is stopped.
- The deceleration-to-a-stop operation commanded by the LX signal decelerates the motor to 0r/min, then zero speed control, servo lock or DC injection brake is performed, regardless of the *Pr.10 and Pr.11* settings.
- Initial magnetic pole detection is not performed for the startup from the pre-excitation status, eliminating the startup delay. (Initial magnetic pole detection is performed if the LX signal is turned from OFF to ON during a stop.)
- To assign the LX signal, set "23" in any of *Pr.178 to Pr.184 (input terminal function selection)*.
- The operation ready 2 signal (RY2) turns ON at the start of pre-excitation.
  The signal stays ON as long as pre-excitation is activated even if the drive unit is in a stop status. The output shutoff signal (MRS signal) is OFF.
  For the operation ready 2 signal (RY2), assign the function by setting "33 (positive logic) or 133 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

(6) Brake operation selection *(Pr.802)* GKR

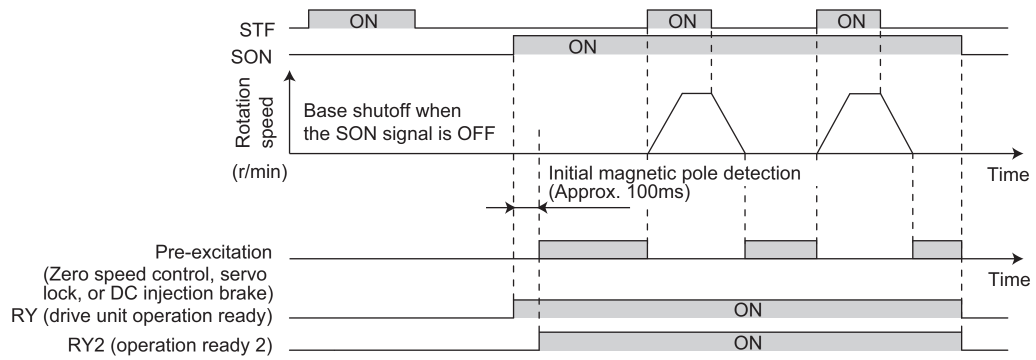
- Select the brake operation when pre-excitation is activated under speed control between zero speed control and servo lock by *Pr.802*. Under position control, servo lock is activated regardless of the *Pr.802* setting.

Pr.802 setting	Pre-excitation	Description
0 (initial value)	Zero speed control	Even under a load, the drive unit does not rotate the motor and holds 0r/min. However, once an external force has rotated the shaft, the shaft is not returned to the original position. This setting is invalid under position control. The drive unit operates according to this setting only under speed control.
1	Servo lock	Even under a load, the drive unit holds the position of the motor shaft. Even after an external force has rotated the shaft, the shaft is returned to the original position. Because position control is performed, the position loop gain can be adjusted in *Pr.422 Position control gain*. Additionally, unstable movement (vibration) can be prevented by adjusting *Pr.698 Speed control D gain*.

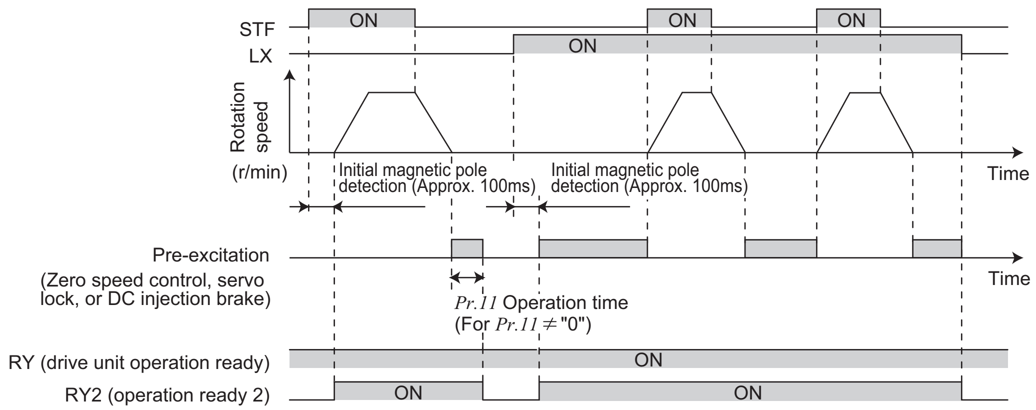
- Operation under speed control

Start signal state		With SON signal assigned		Without SON signal assigned	
		SON signal ON	**SON signal OFF**	**LX signal ON**	**LX signal OFF or without LX signal assigned**
Start signal (STF or STR)	**OFF**	MM-GKR: zero speed control / servo lock S-PM: DC injection brake	Base shutoff	MM-GKR: zero speed control / servo lock S-PM: DC injection brake	Base shutoff
	ON	Operation	Base shutoff	Operation	Operation
RY signal (drive unit operation ready)		ON	OFF	ON	ON

· Operation example by the SON signal under speed control



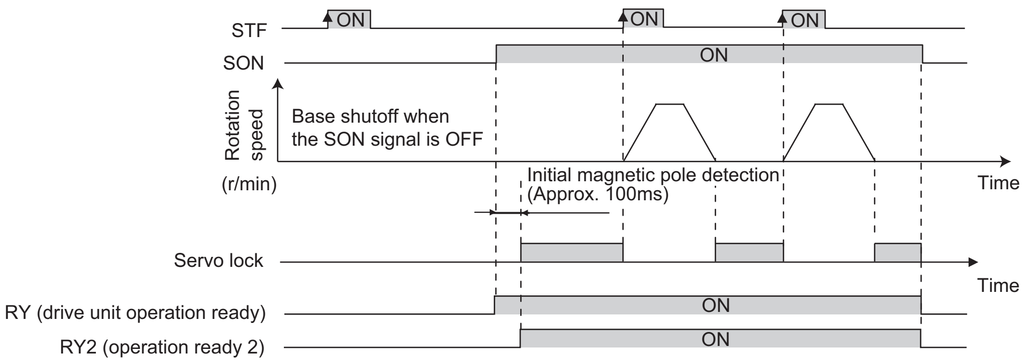
· Operation example by the LX signal under speed control



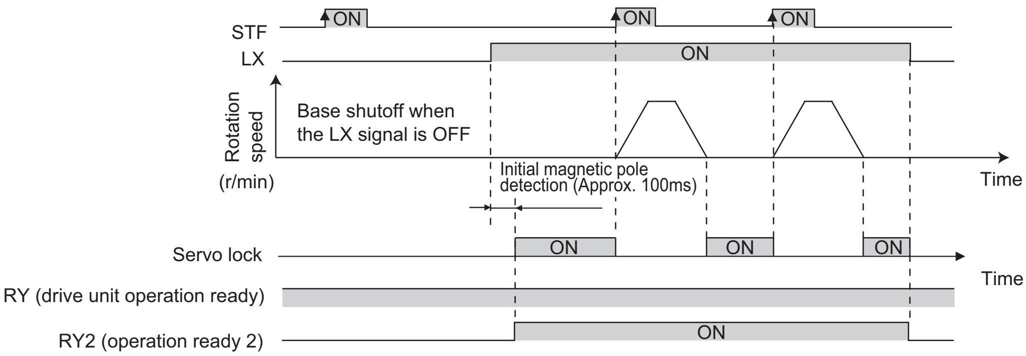
- MM-GKR operation under position control

Start signal state		With SON signal assigned		Without SON signal assigned	
		SON signal ON	**SON signal OFF**	**LX signal ON**	**LX signal OFF**
Start signal (STF or STR)	**OFF**	Servo lock	Base shutoff	Servo lock	Base shutoff
	ON	Operation	Base shutoff	Operation	Base shutoff
RY signal (drive unit operation ready)		ON	OFF	ON	ON

· Operation example by the SON signal under position control



· Operation example by the LX signal under position control



NOTE

- ***Pr.10*** **and** ***Pr.11*** **are invalid during position control.**
- **When terminal assignment is changed using** ***Pr.178 to Pr.184 (input terminal function selection)*** **and** ***Pr.190 to Pr.192 (output terminal function selection)*****, the other functions may be affected. Set parameters after confirming the function of each terminal.** *(Refer to page 138)*

⚠ CAUTION

⚠ **Install a mechanical brake to make an emergency stop or to stay stopped for a long time.**
After the machine is completely stopped and the motor is immobilized using a mechanical brake, turn OFF the servo-ON signal (SON) or the pre-excitation signal (LX).

⚠ **A PM motor is a magnet motor. High-voltage is generated at motor terminals while the motor is running. Do not touch motor terminals and other parts until the motor stops to prevent an electric shock.**

Parameter referred to

Pr.13 Starting speed *Refer to page 128*
Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*
Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

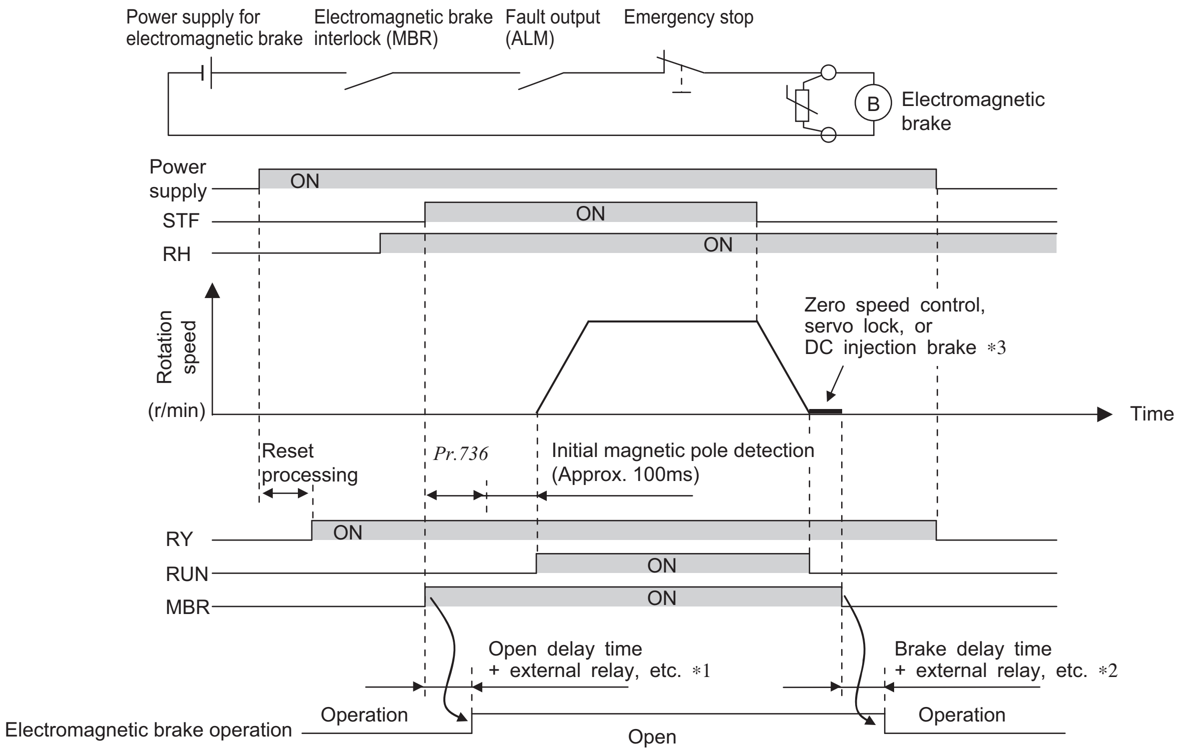
4.11.2 Activating the electromagnetic brake (MBR signal, Pr.736)

Use the electromagnetic brake interlock signal (MBR) to activate the electromagnetic brake.

Parameter number	Name	Initial value	Setting range	Description
736	**Electromagnetic brake interlock time**	0s	0 to 1s	Set the waiting time to start the first magnetic pole detection after drive unit startup and the MBR signal output. Set the open delay time (including relay operation delay) of the electromagnetic brake or longer.

The above parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

- Interlock can be provided for the electromagnetic brake operation by setting a delay from output of the electromagnetic brake interlock signal (MBR) to start of the actual operation in *Pr.736 Electromagnetic brake interlock time*.
- The interlock time set in *Pr.736* is enabled even if the MBR signal is not assigned. Set *Pr.736* = "0" if the interlock time setting is not required.
- For the terminal used for MBR signal output, assign the function by setting "21 (positive logic)" or "121 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.
- Additionally configure an external circuit, which can also command an emergency stop to the electromagnetic brake.



*1 The release of the electromagnetic brake is delayed for the electromagnetic brake release time and the operation time of the relays, etc. in external circuits.
*2 The operation of the electromagnetic brake is delayed for the electromagnetic brake delay time and the operation time of the relays, etc. in external circuits.
*3 When the drive unit is set as *Pr.10* = "0r/min" and *Pr.11* = "0.0s", the outputs are shut off when the speed reaches 0r/min during deceleration, and the motor starts coasting.

Output signal \ Drive unit status	Start signal OFF (during a stop)	Start signal ON: During a stop (no speed setting)	Start signal ON: During a stop (with a speed setting)	Start signal ON: Running	During zero speed control, servo lock or DC injection brake	Output shutoff*
RY	ON	ON	ON	ON	ON	OFF
RUN	OFF	OFF	OFF	ON	OFF	OFF
MBR	OFF	OFF	ON	ON	ON	OFF

* During a fault occurrence, or while the MRS signal is ON

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.** *(Refer to page 138)*
- **The MBR signal is not activated while the main circuit capacitor life is being measured.** *(Refer to page 245)*
- **The motor generates no torque while the electromagnetic brake is open before drive unit operation, or after zero speed control or DC injection brake operation. Thus, the motor may be rotated by an external force. Check that no drop or other accidents will occur in an application like a lift, where the motor rotates while the brake is opened.**

4.11.3 Selection of a regenerative brake (Pr.30, Pr.70)

- When making frequent starts/stops, use the optional brake resistor (MRS type), high-duty brake resistor (FR-ABR) and brake unit (FR-BU2) to increase the regenerative brake duty.
- Use a power regeneration common converter (FR-CV) for continuous operation in regeneration status.
  Use the high power factor converter (FR-HC2) to reduce harmonics, improve the power factor, or continuously use the regenerative status.

Parameter number	Name	Initial value	Setting range	Description
30	**Regenerative function selection**	0	0	Drive unit without regenerative function Brake resistor (MRS type) Brake unit (FR-BU2) Power regeneration common converter (FR-CV) High power factor converter (FR-HC2)
			1	High-duty brake resistor (FR-ABR)
70	**Special regenerative brake duty**	0%	0 to 30%	Brake duty when using the high-duty brake resistor (FR-ABR)

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) When using the brake resistor (MRS type), brake unit (FR-BU2), power regeneration common converter (FR-CV), and high power factor converter (FR-HC2).

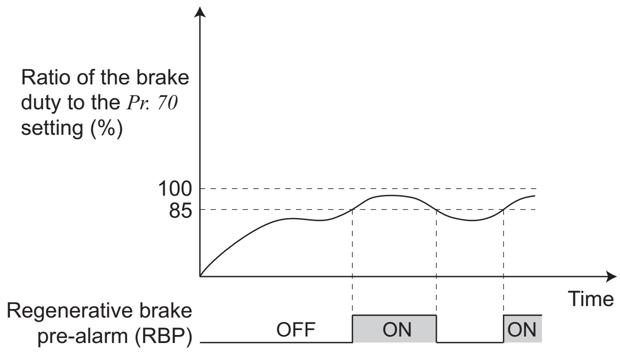
- Set *Pr.30* to "0" (initial value). The *Pr.70* setting is made invalid.
  At this time, the regenerative brake duty is 3%.
- Assign the drive unit operation enable signal (X10) to the contact input terminal. To make protective coordination with the FR-HC2 and FR-CV, use the drive unit operation enable signal to shut off the drive unit output.
  Input the RDY signal of the FR-HC2 (RDYB signal of the FR-CV).
- For the terminal used for X10 signal input, assign its function by setting "10" (X10) to any of *Pr.178 to Pr.184*.

(2) When using the high-duty brake resistor (FR-ABR) (0.4K or higher)

- Set "1" in *Pr.30*.
- Set "10%" in *Pr.70*.

(3) Regenerative brake duty alarm output and alarm signal (RBP signal)

100%: regenerative overvoltage protection operation value



- [RB] appears on the operation panel and an alarm signal (RBP) is output when 85% of the regenerative brake duty set in *Pr.70* is reached. If the regenerative brake duty reaches 100% of the *Pr.70* setting, a regenerative overvoltage (E.OV1 to E.OV3) occurs.
  Note that [RB] is not displayed when *Pr.30* = "0".
- The drive unit does not trip even when the alarm (RBP) signal is output.
- For the terminal used for the RBP signal output, assign the function by setting "7 (positive logic) or 107 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

REMARKS

- The MRS signal can also be used instead of the X10 signal. *(Refer to page 140)*
- *Refer to page 27* to *31* for connecting the brake resistor (MRS type), high-duty brake resistor (FR-ABR), brake unit (FR-BU2), high power factor converter (FR-HC2), and power regeneration common converter (FR-CV).

NOTE

- **When terminal assignment is changed using *Pr.178 to Pr.184 (input terminal function selection)* and *Pr.190 to Pr.192 (output terminal function selection)*, the other functions may be affected. Set parameters after confirming the function of each terminal. *(Refer to page 138)***

⚠ WARNING

⚠ **The value set in *Pr.70* must not exceed the setting of the brake resistor used.
Otherwise, the resistor can overheat.**

Parameters referred to

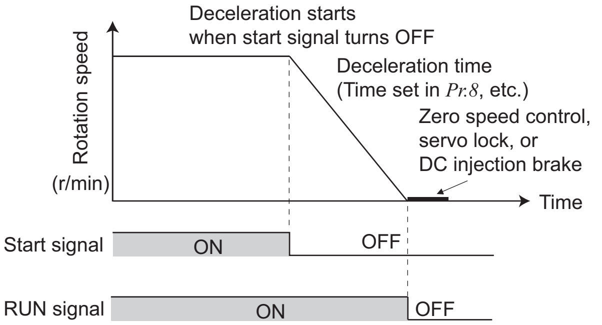
Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*
Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.11.4 Stop selection (Pr.250)

Used to select the stopping method (deceleration to a stop or coasting) when the start signal turns OFF.
Used to stop the motor with a mechanical brake, etc. together with switching OFF of the start signal.
You can also select the operations of the start signals (STF/STR). (*Refer to page 142* for start signal selection)

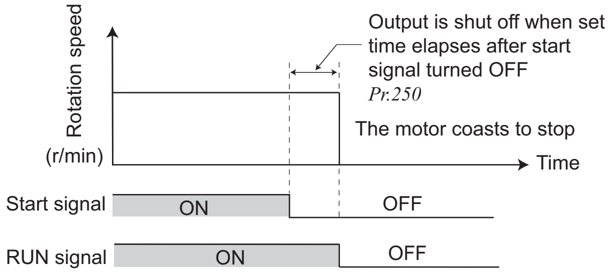
Parameter number	Name	Initial value	Setting range	Description: Start Signal (STF/STR) *(Refer to page 142)*	Description: Stop Operation
250	Stop selection	9999	0 to 100s	STF signal: Forward rotation start STR signal: Reverse rotation start	The motor is coasted to a stop when the preset time elapses after the start signal is turned OFF.
			1000s to 1100s	STF signal: Start signal STR signal: Forward/reverse signal	The motor is coasted to a stop (*Pr.250* - 1000)s after the start signal is turned OFF.
			9999	STF signal: Forward rotation start STR signal: Reverse rotation start	When the start signal is turned OFF, the motor decelerates to stop.
			8888	STF signal: Start signal STR signal: Forward/reverse signal	

The above parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*



(1) Decelerate the motor to a stop

- Set *Pr.250* to "9999" (initial value) or "8888".
- The motor decelerates to a stop when the start signal (STF/STR) turns OFF.



(2) Coast the motor to a stop

- Use *Pr.250* to set the time from when the start signal turns OFF until the output is shut off. When any of "1000 to 1100" is set, the output is shut off in (*Pr.250* - 1000)s.
- The output is shut off when the time set in *Pr.250* has elapsed after the start signal had turned OFF. The motor coasts to a stop.
- The RUN signal turns OFF when the output stops.

REMARKS

- When setting of *Pr.250* is not 9999 nor 8888, acceleration/deceleration is performed according to the speed command, until start signal is OFF and output is shutoff.
- Turning ON the LX signal during pre-excitation will decelerate the motor to a stop even if the motor is set to coast to a stop.

NOTE

- **Stop selection is invalid when the following functions are activated.**
  •Position control
  •PU stop *(Pr.75)*
  •Deceleration stop because of communication error *(Pr.502)*
  •JOG operation mode
- **While the motor is coasting, the operation cannot be restarted. Input the start signal after the motor is stopped to restart the operation.**

⚠ CAUTION

⚠ A PM motor is a magnet motor. High-voltage is generated at motor terminals while the motor is running. Do not touch motor terminals and other parts until the motor stops to prevent an electric shock.

Parameters referred to

Pr.7 Acceleration time, Pr.8 Deceleration time ☞ *Refer to page 125*
Pr.13 Starting speed ☞ *Refer to page 128*

4.12 Function assignment of external terminal and control

Purpose	Parameter to set		Refer to page
To assign function to input terminal	Input terminal function selection	Pr.178 to Pr.184	*138*
To set MRS signal (output shutoff) to NC contact specification	MRS input selection	Pr.17	*140*
To assign start signal and forward/ reverse command to other signals	Start signal (STF/STR) operation selection	Pr.250	*142*
To assign function to output terminal	Output terminal function assignment	Pr.190 to Pr.192	*144*
To detect rotation speed	Up-to-speed sensitivity Rotation speed detection	Pr.41 to Pr.43, Pr.870	*149*
To detect output current	Output current detection Zero current detection	Pr.150 to Pr.153	*150*
To set remote output function	Remote output	Pr.495, Pr.496	*152*

4.12.1 Input terminal function selection (Pr.178 to Pr.184)

Use these parameters to select/change the input terminal functions.

Parameter number	Name	Initial value	Initial Signal	Setting range
178	**STF terminal function selection**	60	STF (forward rotation command)	0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 30, 44, 60∗1, 61∗2, 62, 65 to 67, 76, 86 to 89, 9999
179	**STR terminal function selection**	61	STR (reverse rotation command)	
180	**RL terminal function selection**	0	RL (low-speed operation command)	
181	**RM terminal function selection**	1	RM (middle speed operation command)	
182	**RH terminal function selection**	2	RH (high-speed operation command)	
183	**MRS terminal function selection**	24	MRS (output stop)	
184	**RES terminal function selection**	62	RES (drive unit reset)	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

∗1 The setting value of "60" is available for *Pr.178* only.

∗2 The setting value of "61" is available for *Pr.179* only.

(1) Input terminal function assignment

- Using *Pr.178 to Pr.184*, set the functions of the input terminals.
- Refer to the following table and set the parameters:

Setting	Signal	Function			Related parameters	○: Valid/×: Invalid Speed control	Position control	Refer to page
0	RL	*Pr.59* = 0 (initial value)	Speed control	Low-speed operation command	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239	○	——	*117*
			Position control	Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*
		Pr.59 ≠ 0 ∗1	Speed control	Remote setting (setting clear)	Pr.59	○	○	*122*
			Position control	Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*
1	RM	*Pr.59* = 0 (initial value)	Speed control	Middle-speed operation command	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239	○	——	*117*
			Position control	Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*
		Pr.59 ≠ 0 ∗1	Speed control	Remote setting (deceleration)	Pr.59	○	——	*122*
			Position control	Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*

Setting	Signal	Function	Related parameters	○: Valid/×: Invalid — Speed control	○: Valid/×: Invalid — Position control	Refer to page
2	RH	*Pr.59* = 0 (initial value) — Speed control — High-speed operation command	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239	○	——	*117*
		Pr.59 = 0 (initial value) — Position control — Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*
		Pr.59 ≠ 0 *1 — Speed control — Remote setting (acceleration)	Pr.59	○	——	*122*
		Pr.59 ≠ 0 *1 — Position control — Table selection signal	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.465 to Pr.478, etc.	——	○	*95*
3	RT	Second function selection	Pr.44, Pr.45, Pr.48	○	×	*141*
4	AU	Terminal 4 input selection	Pr.267	○	×	*168*
5	JOG	Jog operation selection	Pr.15, Pr.16	○	○	*119*
7	OH	External thermal relay input *2	Pr.9	○	○	*130*
8	REX	15-speed selection (combination with three speeds RL, RM, RH)	Pr.4 to Pr.6, Pr.24 to Pr.27, Pr.232 to Pr.239	○	×	*117*
10	X10	Drive unit run enable signal (FR-HC2, FR-CV connection)	Pr.30, Pr.70	○	○	*136*
12	X12	PU operation external interlock	Pr.79	○	○	*186*
14	X14	PID control valid terminal	Pr.127 to Pr.134	○	×	*235*
16	X16	PU-External operation switchover (turning ON X16 selects External operation)	Pr.79, Pr.340	○	○	*192*
23	LX	Pre-excitation	Pr.11	○	○	*132*
24	MRS	Output stop	Pr.17	○	○	*140*
25	STOP	Start self-holding selection	——	○	×	*142*
29	X29	Stopper control switchover	Pr.512 to Pr.515	○	○	*102*
30	JOG2	JOG operation selection 2	Pr.15, Pr.16	○	○	*119*
44	X44	P/PI control switchover (P control with X44-ON)	Pr.820, Pr.821	○	×	*80*
60	STF	Forward rotation command (assigned to STF terminal *(Pr.178)* only)	——	○	○	*142*
61	STR	Reverse rotation command (assigned to STR terminal *(Pr.179)* only)	——	○	○	*142*
62	RES	Drive unit reset	——	○	○	——
65	X65	PU/NET operation switchover (turning ON X65 selects PU operation)	Pr.79, Pr.340	○	○	*192*
66	X66	External/NET operation switchover (turning ON X66 selects NET operation)	Pr.79, Pr.340	○	○	*192*
67	X67	Command source switchover (turning ON X67 makes *Pr.338* and *Pr.339* commands valid)	Pr.338, Pr.339	○	○	*195*
76	X76	Proximity dog	Pr.532	×	○	*107*
86	SON	Servo-ON	Pr.802	○	○	*132*
87	X87	Position control sudden stop	Pr.464, Pr.535	×	○	*100*
88	LSP	Forward stroke end	Pr.464, Pr.535	×	○	*101*
89	LSN	Reverse stroke end	Pr.464, Pr.535	×	○	*101*
9999	——	No function	——	——	——	——

*1 When *Pr.59 Remote function selection* ≠ "0", the functions of the RL, RM and RH signals are changed as given in the table.
*2 The OH signal turns ON when the relay contact "opens".

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**
- **Same function can be assigned to two or more terminals. In this case, the logic of terminal input is OR.**
- **The priorities of the speed commands are in order of JOG (JOG2) > multi-speed setting (RH, RM, RL, REX) > PID (X14).**
- **When the X10 signal (FR-HC2, FR-CV connection-drive unit operation enable signal) is not set or when the PU operation external interlock (X12) signal is not assigned with *Pr.79 Operation mode selection* set to "7", the MRS signal shares this function.**
- **Same signal is used to assign multi-speed (7 speeds) and remote setting. They cannot be set individually.**
  (Same signal is used since multi-speed (7 speeds) setting and remote setting are not used to set speed at the same time.)
- **Turning the AU signal ON makes terminal 2 (voltage input) invalid.**

(2) Response time of each signal

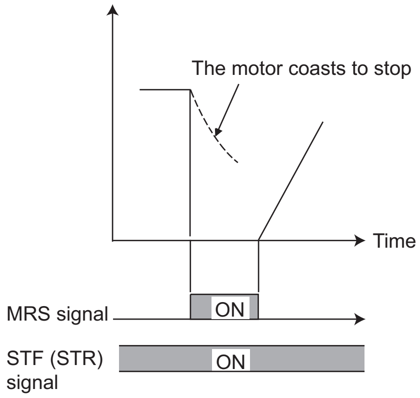
- The response time of the X10 signal and MRS signal is within 2ms.
  The response time of other signals is within 20ms.

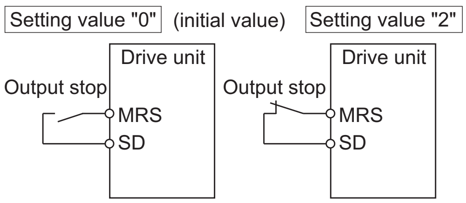
4.12.2 Drive unit output shutoff signal (MRS signal, Pr.17)

The drive unit output can be shut off by the MRS signal. Also, logic for the MRS signal can be selected.

Parameter number	Name	Initial value	Setting range	Description
17	**MRS input selection**	0	0	Normally open input
			2	Normally closed input (NC contact input specifications)
			4	External terminal: Normally closed input (NC contact input specifications) Communication: Normally open input

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*





(1) Output shutoff signal (MRS signal)

- Turning ON the output shutoff signal (MRS) during drive unit running shuts off the output immediately.
- MRS signal may be used as described below.

(a) When mechanical brake (e.g. electromagnetic brake) is used to stop motor
The drive unit output is shut off when the mechanical brake operates.

(b) To provide interlock to disable operation by the drive unit
With the MRS signal ON, the drive unit cannot be operated if the start signal is entered into the drive unit.

(c) Coast the motor to a stop.
When the start signal is turned OFF, the drive unit decelerates the motor to a stop in the preset deceleration time, but when the MRS signal is turned ON, the motor coasts to a stop.

(2) MRS signal logic inversion *(Pr.17)*

- When *Pr.17* is set to "2", the MRS signal (output stop) can be changed to the normally closed (NC contact) input specification. When the MRS signal turns ON (opens), the drive unit shuts off the output.

(3) Assign a different action for each MRS signal input from communication and external terminal (*Pr.17* = "4")

- When *Pr.17* is set to "4", the MRS signal from external terminal (output stop) can be changed to the normally closed (NC contact) input, and the MRS signal from communication can be changed to the normally open (NO contact) input.
  This function is useful to perform operation by communication with MRS signal from external terminal remained ON.

External MRS	Communication MRS	*Pr.17* Setting		
		0	2	4
OFF	OFF	Operation enabled	Output shutoff	Output shutoff
OFF	ON	Output shutoff	Output shutoff	Output shutoff
ON	OFF	Output shutoff	Output shutoff	Operation enabled
ON	ON	Output shutoff	Operation enabled	Output shutoff

REMARKS

- For MRS signal, assign the function by setting "24" to any of *Pr.178 to Pr.184 (Input terminal function selection)*.
- When using an external terminal to input the MRS signal, the MRS signal shuts off the output in any of the operation modes.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

CAUTION

A PM motor is a magnet motor. High-voltage is generated at motor terminals while the motor is running. Do not touch motor terminals and other parts until the motor stops to prevent an electric shock.

Parameter referred to

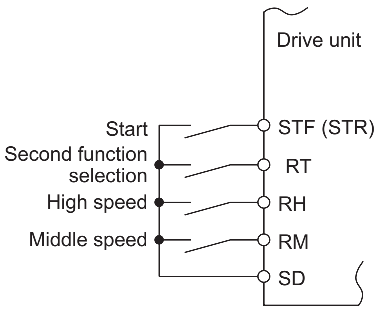
Pr.178 to Pr.184 (input terminal function selection) Refer to page 138

4.12.3 Condition selection of function validity by second function selection signal (RT)

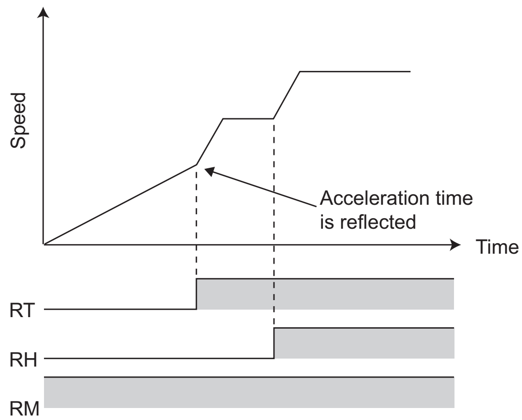
You can select the second function using the RT signal.

- When the RT signal turns ON, the second function becomes valid.
- For the RT signal, set "3" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.
- The second function has the following applications.
  (a)Switching between normal use and emergency use
  (b)Switching between heavy load and light load
  (c)Changing of acceleration/deceleration time by broken line acceleration/deceleration

Second function connection diagram



Second acceleration/deceleration time



- When the RT signal is ON, the following second function is selected at the same time.

Function	First Function Parameter Number	Second Function Parameter Number	Refer to Page
Acceleration time	*Pr.7*	*Pr.44*	*125*
Deceleration time	*Pr.8*	*Pr.44, Pr.45*	*125*
Torque limit	*Pr.22*	*Pr.48*	*111*

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameter referred to

Pr.178 to Pr.184 (input terminal function selection) Refer to page 138

4

PARAMETERS

4.12.4 Start signal operation selection (STF, STR, STOP signal, Pr.250)

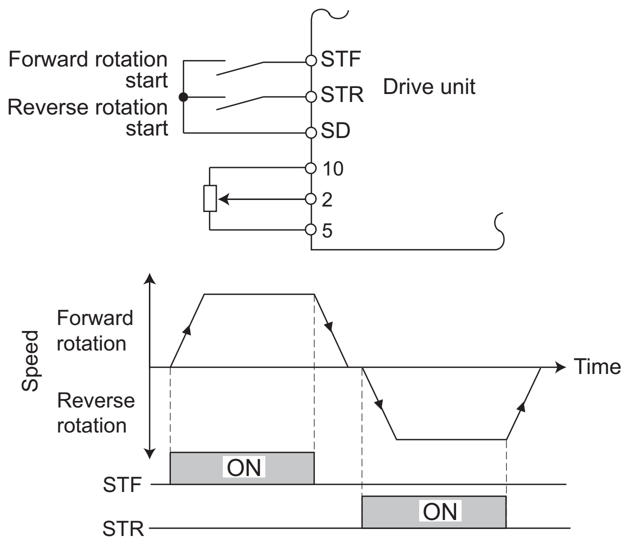
You can select the operation of the start signal (STF/STR).
Used to select the stopping method (deceleration to a stop or coasting) when the start signal turns OFF.
Used to stop the motor with a mechanical brake, etc. together with switching OFF of the start signal.
(Refer to *page 137* for stop selection)

Parameter number	Name	Initial value	Setting range	Description	
				Start Signal (STF/STR)	Stop Operation *(Refer to page 137)*
250	**Stop selection**	9999	0 to 100s	STF signal: Forward rotation start STR signal: Reverse rotation start	The motor is coasted to a stop when the preset time elapses after the start signal is turned OFF.
			1000s to 1100s	STF signal: Start signal STR signal: Forward/reverse signal	When the setting is any of 1000s to 1100s, the drive unit coasts to a stop in (*Pr.250* - 1000)s.
			9999	STF signal: Forward rotation start STR signal: Reverse rotation start	When the start signal is turned OFF, the motor decelerates to stop.
			8888	STF signal: Start signal STR signal: Forward/reverse signal	

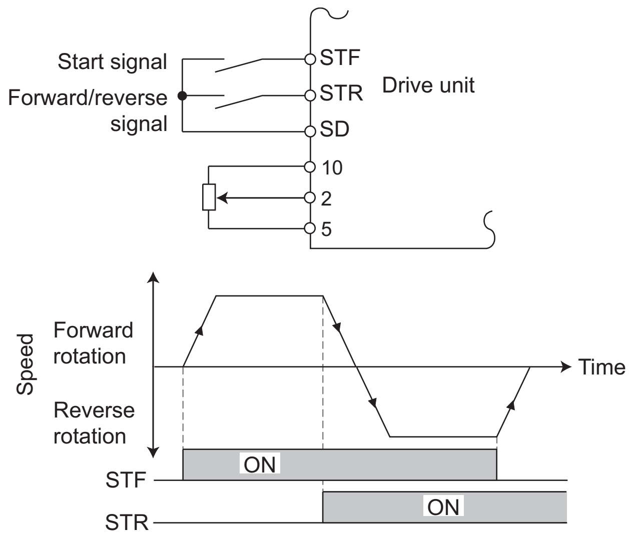
The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Two-wire type connection (STF, STR signal)

- The two-wire connection is shown below.
- In the default setting, the forward/reverse rotation signals (STF/STR) are used as start and stop signals. Turn ON either of the forward and reverse rotation signals to start the motor in the corresponding direction. Switch both OFF (or both ON) of the start signals during operation to decelerate the drive unit to a stop.
- The speed setting signal may either be given by entering 0 to 10VDC across the speed setting input terminal 2-5, by setting the required values in *Pr.4 to Pr.6 Multi-speed setting (high, middle, low speeds)*, etc.
  (For multi-speed operation, *refer to page 117*.)
- When *Pr.250* is set to any of "1000 to 1100, 8888", the STF signal becomes a start command and the STR signal a forward/reverse command.



2-wire connection example (*Pr.250* = "9999")



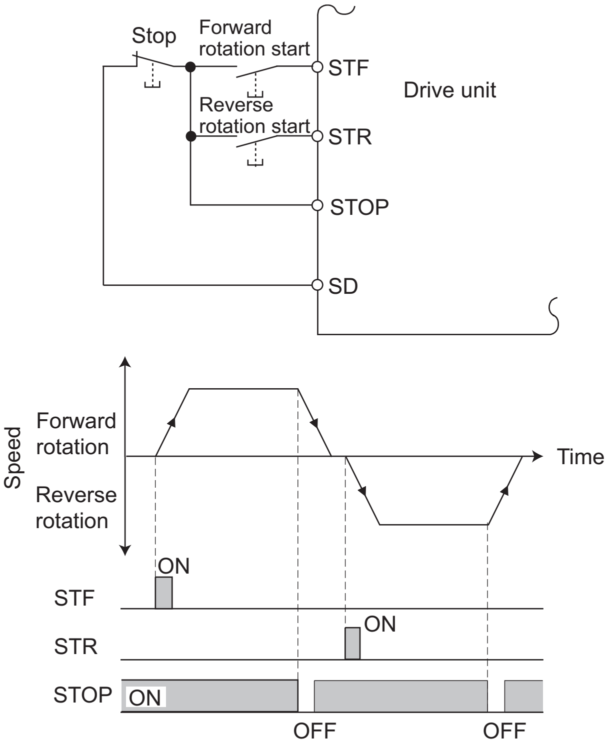
2-wire connection example (*Pr.250* = "8888")

REMARKS

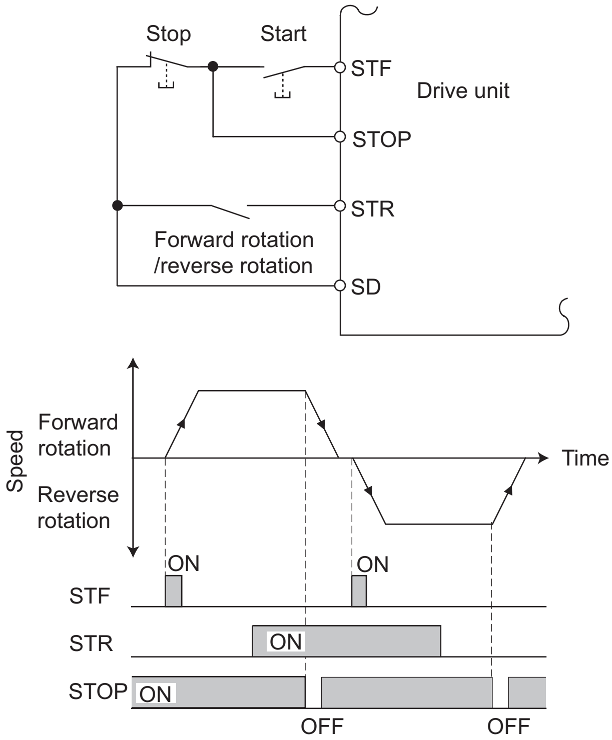
- When *Pr.250* is set to any of "0 to 100, 1000 to 1100", turning OFF the start command coasts the drive unit to a stop. *(Refer to page 137)*
- The STF and STR signals are assigned to the STF and STR terminals in the default setting. The STF signal can be assigned to *Pr.178 STF terminal function selection*, and the STR signal to *Pr.179 STR terminal function selection*.

(2) Three-wire type (STF, STR, STOP signal)

- The three-wire connection is shown below.
- Turning the STOP signal ON makes start self-holding function valid. In this case, the forward/reverse rotation signal functions only as a start signal.
- If the start signal (STF or STR) is turned ON and then OFF, the start signal is held and makes a start. When changing the direction of rotation, turn STR (STF) ON once and then OFF.
- To stop the drive unit, turning off the STOP signal once decelerates it to a stop.
- When using the STOP signal, set "25" in *Pr.178 to Pr.184* to assign function.



3-wire connection example (*Pr.250* = "9999")



3-wire connection example (*Pr.250* = "8888")

REMARKS

- When the JOG signal is turned ON to enable Jog operation, the STOP signal becomes invalid.
- If the MRS signal is turned ON to stop the output, the self-holding function is not canceled.

NOTE

- **Under position control, the three-wire type is not available.**

(3) Start signal selection

STF	STR	*Pr.250* Setting Drive Unit Status	
		0 to 100s, 9999	1000s to 1100s, 8888
OFF	OFF	Stop	Stop
OFF	ON	Reverse rotation	
ON	OFF	Forward rotation	Forward rotation
ON	ON	Stop	Reverse rotation

Parameters referred to

Pr.4 to Pr.6 (multi-speed setting) ☞ *Refer to page 117*

Pr.178 to Pr.184 (input terminal function selection) ☞ *Refer to page 138*

4.12.5 Output terminal function selection (Pr.190 to Pr.192)

You can change the functions of the open collector output terminal and relay output terminal.

Parameter number	Name		Initial value	Initial signal	Setting range
190 Ver.UP	**RUN terminal function selection**	**Open collector output terminal**	0	RUN (drive unit runnning)	0, 1, 3, 4, 7, 8, 11 to 16, 21, 24 to 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 68∗2, 90, 91, 93∗1, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124 to 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 168∗2, 190, 191, 193∗1, 195, 196, 198, 199, 9999
191 Ver.UP	**FU terminal function selection**		4	FU (rotation speed detection)	
192 Ver.UP	**A,B,C terminal function selection**	**Relay output terminal**	99	ALM (fault output)	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

∗1 The setting values "93" and "193" are available only in *Pr.190 and Pr.191*.

∗2 The setting values "68" and "168" are valid only when used with FR-E7DS. (For the details, refer to the Instruction Manual of FR-E7DS.)

Ver.UP ...... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

(1) Output signal list

- You can set the functions of the output terminals.
- Refer to the following table and set the parameters: (0 to 99: positive logic, 100 to 199: negative logic)

Setting: Positive logic	Setting: Negative logic	Signal	Function	Operation		Related parameter	Refer to page
0	100	RUN	Drive unit running	Speed control	Output when the drive unit starts running upon turning ON of the start signal. Turned OFF when the drive unit performs deceleration stop and zero speed control or servo lock is activated.	——	*147*
				Position control	Same operation as that of the RY2 signal		
1	101	SU	Up to speed ∗1	Speed control	Output when the rotation speed is reached to the set speed.	Pr.41, Pr.870	*149*
				Position control	——		
3	103	OL	Overload alarm	Output while torque limit function is activated.		Pr.22, Pr.48, Pr.156, Pr.157	*111*
4	104	FU	Rotation speed detection	Output when the rotation speed reaches the speed set in *Pr.42* (*Pr.43* for reverse rotation).		Pr.42, Pr.43, Pr.870	*149*
7	107	RBP	Regenerative brake pre-alarm	Output when 85% of the regenerative brake duty set in *Pr.70* is reached.		Pr.70	*136*
8	108	THP	Electronic thermal O/L relay pre-alarm	Output when the electronic thermal value reaches 85% of the trip level. (Electronic thermal relay function protection (E.THT/E.THM) activates, when the value reached 100%.)		Pr.9	*130*
11	111	RY	Drive unit operation ready	Output when reset process is completed (when the drive unit can be started by switching the start signal ON or while it is running) after power-ON of the drive unit.		——	*147*
12	112	Y12	Output current detection	Output when the output current is the *Pr.150* setting or higher for longer than the time set in *Pr.151*.		Pr.150, Pr.151	*150*
13	113	Y13	Zero current detection	Output when the output power is the *Pr.152* setting or lower for longer than the time set in *Pr.153*.		Pr.152, Pr.153	*150*

Setting		Signal	Function	Operation		Related parameter	Refer to page
Positive logic	Negative logic						
14	114	FDN	PID lower limit	Speed control	Output when the feedback value falls below the lower limit of PID control.	Pr.127 to Pr.134	*235*
				Position control	——		
15	115	FUP	PID upper limit	Speed control	Output when the feedback value rises above the upper limit of PID control		
				Position control	——		
16	116	RL	PID forward/reverse rotation output	Speed control	Output when forward rotation is performed in PID control.		
				Position control	——		
21	121	MBR	Electromagnetic brake interlock	Output to open the electromagnetic brake.		Pr.736	*135*
24	124	LP	Stroke limit warning	Output when the LSP or LSN signal is OFF (normally closed input).		Pr.464, Pr.535	*101*
25	125	FAN	Fan fault output	Output at the time of a fan fault.		Pr.244	*244*
26	126	FIN	Heatsink overheat pre-alarm	Output when the heatsink temperature reaches about 85% of the heatsink overheat protection providing temperature.		——	*274*
33	133	RY2	Operation ready 2	Output during pre-excitation and operation.		Pr.10, Pr.11	*132, 147*
36	136	Y36	In-position	Speed control	——	Pr.426, Pr.506, Pr.507, Pr.510, Pr.511, Pr.530	*109*
				Position control	Output when the number of droop pulses drops below the setting of *Pr.426* In-position width.		
38	138	MEND	Travel completed	Speed control	——		
				Position control	Output when the in-position signal (Y36) is ON and the position command creating signal (PBSY) is OFF.		
47	147	PID	During PID control activated	Output during PID control.		Pr.127 to Pr.134	*235*
55	155	CPO	Rough match	Speed control	——	Pr.426, Pr.506, Pr.507, Pr.510, Pr.511, Pr.530	*109*
				Position control	Output when the remaining command distance falls below the setting of *Pr.507 Rough match output range*.		
56	156	ZA	Home position return failure warning	Speed control	——		
				Position control	Output when a home position return failure occurs.		
60	160	FP	Position detected	Speed control	——		
				Position control	Output when the current position exceeds the total of *Pr.510 Position detection lower 4 digits* and *Pr.511 Position detection upper 4 digits*.		
61	161	PBSY	Position command creating	Speed control	——		
				Position control	Output when the position command is being created.		
63	163	ZP	Home position return completed	Speed control	——		
				Position control	Output after home position return is completed.		

Setting		Signal	Function	Operation	Related parameter	Refer to page
Positive logic	Negative logic					
64	164	Y64	During retry	Output during retry processing.	Pr.65 to Pr.69	*164*
68	168	EV	24V external power supply operation	The signal is output while the main circuit power supply is off and the 24V power is supplied externally. This signal is available when FR-E7DS is mounted.	——	——
90	190	Y90	Life alarm	Output when any of the control circuit capacitor, main circuit capacitor and inrush current limit circuit or the cooling fan approaches the end of its service life.	Pr.255 to Pr.259	*245*
91	191	Y91	Fault output 3 (power-off signal)	Output when a fault occurs due to the internal circuit failure of the drive unit wiring mistake.	——	*148*
93	193	Y93	Current average value monitor signal	Average current value and maintenance timer value are output as pulses. The signal can not be set in *Pr.192 A,B,C terminal function selection*.	Pr.555 to Pr.557	*249*
95	195	Y95	Maintenance timer signal	Output when *Pr.503* rises to or above the *Pr.504* setting.	Pr.503, Pr.504	*248*
96	196	REM	Remote output	Output to the terminal when a value is set to the parameter.	Pr.495, Pr.496	*152*
98	198	LF	Alarm output	Output when an alarm (communication error warning) occurs.	Pr.121	*204*
99	199	ALM	Fault output	Output when the drive unit's protective function is activated to stop the output (at fault occurrence). The signal output is stopped when the fault is reset.	——	*148*
9999		——	No function	——	——	——

*1 Note that when the speed setting is varied using an analog signal or of the operation panel, the output of the SU (up to speed) signal may alternate ON and OFF depending on that varying speed and the timing of the varying speed due to acceleration/deceleration time setting.
(The output will not alternate ON and OFF when the acceleration/deceleration time setting is "0s".)

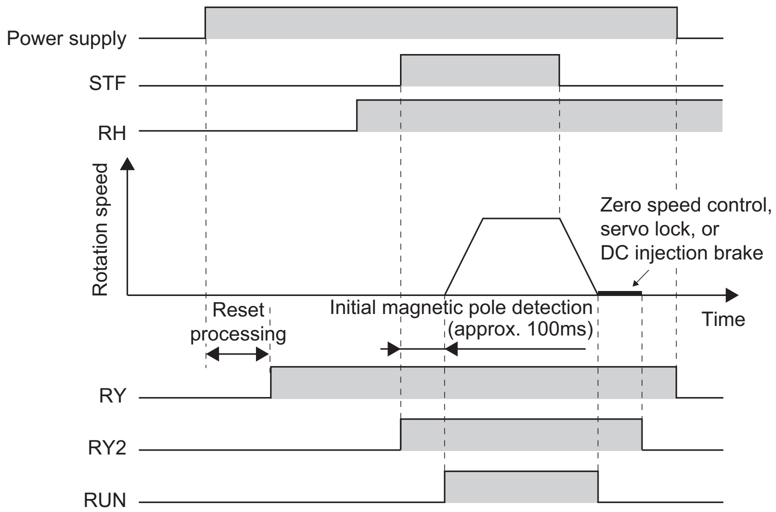
REMARKS

- The same function may be set to more than one terminal.
- When the function is executed, the terminal conducts at the setting of any of "0 to 99", and does not conduct at the setting of any of "100 to 199".

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**
- **Do not assign signals which repeat frequent ON/OFF to terminal A, B, C. Otherwise, the life of the relay contact decreases.**

(2) Drive unit operation ready signal (RY signal) and drive unit running signal (RUN signal)



- When the drive unit is ready to operate, the output of the operation ready signal (RY) is ON. (It is also ON during drive unit running.)
- When the output speed of the drive unit rises to or above 1r/min, the drive unit running signal (RUN) is turned ON. During a drive unit stop, zero speed control, servo lock, or DC injection brake operation, the output is OFF.
- The RY2 signal turns ON when the pre-excitation starts.
  The signal stays ON as long as pre-excitation is activated even if the drive unit is in a stop status. The output shutoff signal (MRS) is OFF. *(Refer to page 132)*
- When using the RY, RY2 and RUN signals, assign functions to *Pr.190 to Pr.192 (output terminal selection function)* referring to the table below.

Output signal	*Pr.190 to Pr.192* setting	
	Positive logic	Negative logic
RY	11	111
RY2	33	133
RUN	0	100

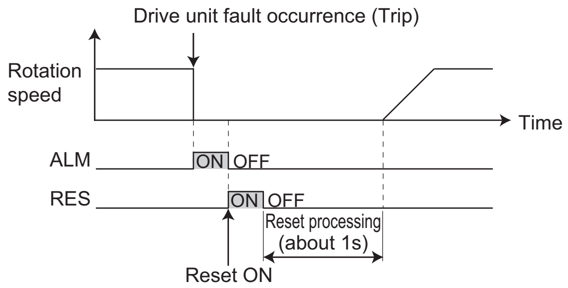
Drive unit status / Output signal	During stop	During operation	LX signal ON (pre-excitation)	Under zero speed control or during DC injection brake operation (pre-excitation)	Output shutoff *2
RY	ON	ON	ON	ON	OFF
RY2	OFF	ON*1	ON*1	ON	OFF
RUN	OFF	ON	OFF	OFF	OFF

*1 There is a 100ms time delay at ON.
*2 During a fault occurrence, while the MRS signal is ON, while the SON signal is OFF, etc.

REMARKS

- The RUN signal (positive logic) is assigned to the terminal RUN in the initial setting.
- When the start command (STF, STR) is turned ON during PM motor control, the RUN signal is output after *Pr.736 Electromagnetic brake interlock time* plus about 100ms. This delay is caused by the electromagnetic brake interlock and magnetic pole detection. *(Refer to page 135)*

(3) Fault output signal (ALM signal)



- If the drive unit comes to trip, the ALM signal is output.

REMARKS

- The ALM signal is assigned to the terminal A, B, C in the default setting. By setting "99 (positive logic) or 199 (negative logic) in *Pr.190 to Pr.192 (output terminal function selection)*, the ALM signal can be assigned to the other terminal.
- Refer to *page 268* for the drive unit fault description.

(4) Fault output 3 (power-off signal) (Y91 signal)

- The Y91 signal is output at occurrence of a fault attributable to the failure of the drive unit circuit or a fault caused by a wiring mistake.
- When using the Y91 signal, set "91 (positive logic)" or "191 (negative logic)" to any of *Pr.190 to Pr.192 (output terminal function selection)* to assign the function to the output terminal.
- The following table indicates the faults that will output the Y91 signal. (Refer to *page 267* for the fault description.)

Operation Panel Indication		Name
E. bE	**E. BE**	Brake transistor alarm detection
E. GF	**E.GF**	Output side earth (ground) fault overcurrent
E. LF	**E.LF**	Output phase loss
E. PE	**E.PE**	Parameter storage device fault
E.PE2	**E.PE2**	Internal board fault
E. 6/ E. 7/ E.CPU/	**E. 6/ E. 7/ E.CPU**	CPU fault
E.IOH	**E.IOH**	Inrush current limit circuit fault

REMARKS

- At occurrence of Output side earth (ground) fault overcurrent, overcurrent trip during acceleration(E.OC1) may be displayed. At this time, the Y91 signal is output.

4.12.6 Detection of rotation speed (SU, FU signal, Pr.41 to Pr.43, Pr.870)

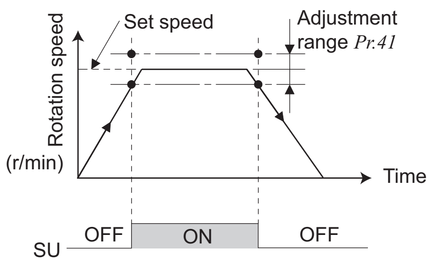
The drive unit rotation speed is detected and output at the output signals.

Parameter number	Name	Initial value	Setting range	Description
41	**Up-to-speed sensitivity**	10%	0 to 100%	Level where the SU signal turns ON.
42	**Speed detection**	180r/min	0 to 4800r/min *1	Speed where the FU signal turns ON
43	**Speed detection for reverse rotation**	9999	0 to 4800r/min *1	Speed where the FU signal turns ON during reverse rotation.
			9999	Same as *Pr.42* setting
870	**Speed detection hysteresis**	15r/min	0 to 180r/min *2	Set the hysteresis width for the detected speed.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

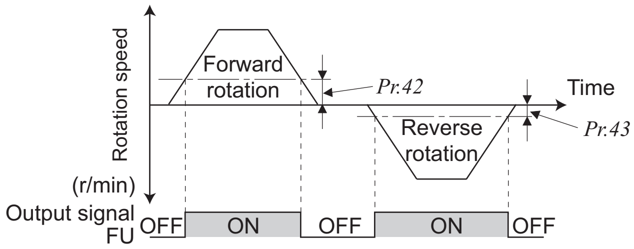
*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

*2 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 450 r/min, 3.7K: 300 r/min)



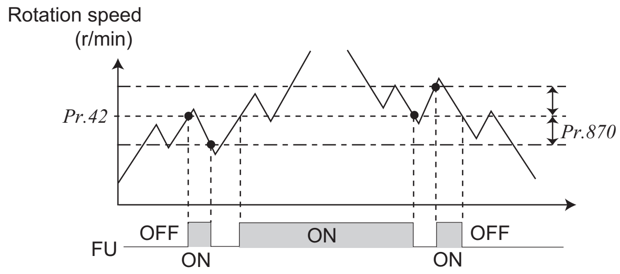
(1) Up-to-speed sensitivity (SU signal, *Pr.41*)

- When the rotation speed reaches the set speed, the up-to-speed signal (SU) is output.
- The *Pr.41* value can be adjusted within the range 0% to ±100% on the assumption that the set speed is 100%.
- This parameter can be used to ensure that the running speed has been reached to provide the operation start signal etc. for related equipment.
- When using the SU signal, set "1 (positive logic) or 101 (negative logic)" in *Pr.190 to Pr.192 (output terminal function selection)* to assign function to the output terminal.



(2) Rotation speed detection (FU signal, *Pr.42, Pr.43*)

- The rotation speed detection signal (FU) is output when the rotation speed reaches or exceeds the *Pr.42* setting.
- Speed detection that is dedicated to the reverse operation can be set by setting detection speed to *Pr.43*.
- When *Pr.43* ≠ "9999", the *Pr.42* setting is used for forward rotation and the *Pr.43* setting is used for reverse rotation.



Example of rotation speed detection signal (FU)

(3) Speed detection hysteresis *(Pr.870)*

- This function prevents chattering of the speed detection signals.
When the rotation speed fluctuates, the up-to-speed signal (SU) and rotation speed detection signal (FU) may repeat ON/ OFF (chatter). Setting hysteresis to the detected speed prevents chattering of these signals.

REMARKS

- Setting a higher value to this parameter slows the response of speed detection signals (SU and FU).

REMARKS

- The FU signal is assigned to the terminal FU in the initial setting. The FU signal can also be assigned to the other terminal by setting "4 (positive logic) or 104 (negative logic)" in any of *Pr.190 to Pr.192*.
- All signals are OFF during zero speed control.
- Under position control, the SU signal is invalid.

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameter referred to

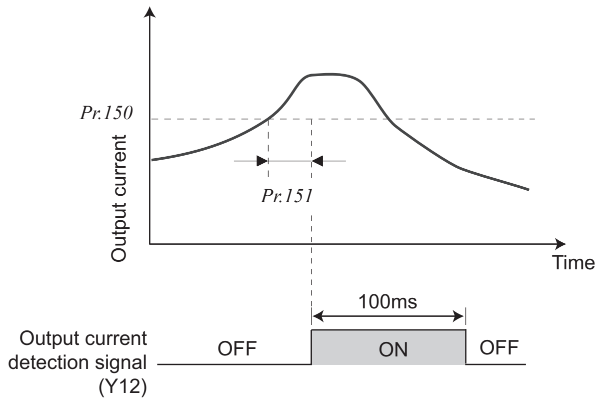
Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.12.7 Output current detection function (Y12 signal, Y13 signal, Pr.150 to Pr.153)

The output current during drive unit running can be detected and output to the output terminal.

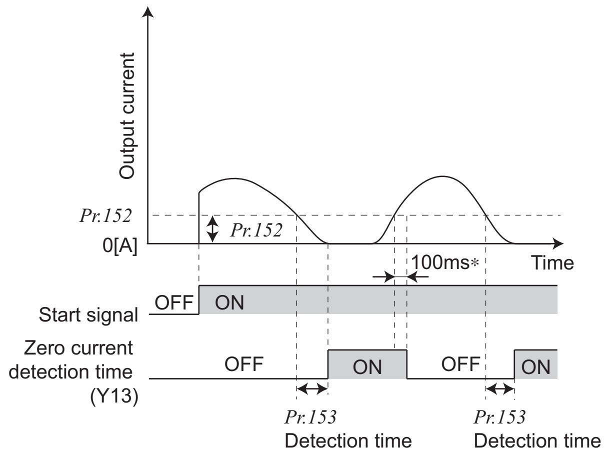
Parameter number	Name	Initial value	Setting range	Description
150	**Output current detection level**	150%	0 to 200%	100% is the rated drive unit current.
151	**Output current detection signal delay time**	0s	0 to 10s	Output current detection period. The time from when the output current has risen above the setting until the output current detection signal (Y12) is output.
152	**Zero current detection level**	5%	0 to 200%	The rated drive unit current is assumed to be 100%.
153	**Zero current detection time**	0.5s	0 to 1s	Period from when the output current drops below the *Pr.152* value until the zero current detection signal (Y13) is output.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". (*Refer to page 182*)



(1) Output current detection (Y12 signal, *Pr.150*, *Pr.151*)

- The output current detection function can be used for excessive torque detection, etc.
- If the output current remains at the *Pr.150* setting or higher during drive unit operation for longer than the time set in *Pr.151*, the output current detection signal (Y12) is output from the drive unit's open collector or relay output terminal.
- When the Y12 signal turns ON, the ON state is held for approximately 100ms.
- For the Y12 signal, set "12 (positive logic) or 112 (negative logic)" in *Pr.190 to Pr.192 (output terminal function selection)* and assign functions to the output terminal.



* The zero current detection signal (Y13) holds the signal for approximately 100ms once turned ON.

(2) Zero current detection (Y13 signal, *Pr.152*, *Pr.153*)

- If the output current remains at the *Pr.152* setting or lower during drive unit operation for longer than the time set in *Pr.153*, the zero current detection (Y13) signal is output from the drive unit's open collector or relay output terminal.
- When the drive unit's output current falls to "0", torque will not be generated. This may cause a drop due to gravity when the drive unit is used in vertical lift application.
  To prevent this, the Y13 signal can be output from the drive unit to close the mechanical brake when the output current has fallen to "zero".
- For the Y13 signal, set "13 (positive logic) or 113 (negative logic)" in *Pr.190 to Pr.192 (output terminal function selection)* and assign functions to the output terminal.

REMARKS

- The response time of Y12 and Y13 signals is approximately 0.1s. Note that the response time changes according to the load condition.
- When *Pr.152* = "0", detection is disabled.

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192* (output terminal function selection) may affect the other functions. Set parameters after confirming the function of each terminal.**

⚠ CAUTION

⚠ **The zero current detection level setting should not be too low, and the zero current detection time setting not too long. Otherwise, the detection signal may not be output when torque is not generated at a low output current.**

⚠ **To prevent the machine and equipment from resulting in hazardous conditions detection signal, install a safety backup such as an emergency brake even the zero current detection function is set valid.**

Parameter referred to

Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.12.8 Remote output selection (REM signal, Pr.495, Pr.496)

You can utilize the ON/OFF of the drive unit's output signals instead of the remote output terminal of the programmable logic controller.

Parameter number	Name	Initial value	Setting range	Description	
495	**Remote output selection**	0	0	Remote output data clear at powering OFF	Remote output data is cleared during a drive unit reset
			1	Remote output data retention at powering OFF	
			10	Remote output data clear at powering OFF	Remote output data is retained during a drive unit reset
			11	Remote output data retention at powering OFF	
496*	**Remote output data 1**	0	0 to 4095	Refer to the following diagram.	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

* This parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

<Remote output data>

Pr.496

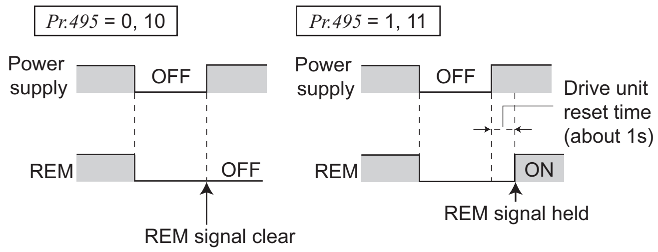
b11											b0
*	*	*	*	*	*	ABC	FU	*	*	*	RUN

* Any

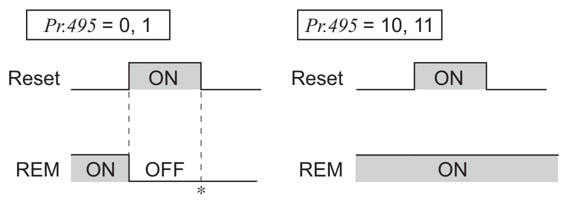
- The output terminal can be turned ON/OFF depending on the *Pr.496* setting. The remote output selection can be controlled ON/OFF by computer link communication from the PU connector or by communication from the communication option.
- Set "96 (positive logic) or 196 (negative logic)" to any of *Pr.190 to Pr.192 (output terminal function selection)*, and assign the remote output (REM) signal to the terminal used for remote output,
- When you refer to the diagram on the left and set 1 to the terminal bit (terminal where the REM signal has been assigned) of *Pr.496*, the output terminal turns ON (OFF for negative logic). By setting 0, the output terminal turns OFF (ON for negative logic).

Example: When "96 (positive logic)" is set in *Pr.190 RUN terminal function selection* and "1" (H01) is set in *Pr.496*, the terminal RUN turns ON.

ON/OFF example for positive logic



Signal condition during a reset



* When *Pr.495* = "1," the signal condition saved in EEPROM (condition of the last power OFF) is applied.

- When *Pr.495* = "0 (initial value), 10", performing a power ON reset (including a power failure) clears the REM signal output. (The ON/OFF status of the terminals are as set in *Pr.190 to Pr.192.*) The *Pr.496* settings are also "0".
  When *Pr.495* = "1, 11", the remote output data before power OFF is stored into the EEPROM, so the signal output at power recovery is the same as before power OFF. (See the chart on the left) However, it is not stored when the drive unit is reset (terminal reset, reset request through communication).
- When *Pr.495* = "10 or 11," the signal before the reset is held even during a drive unit reset.

REMARKS

- The output terminal where the REM signal is not assigned using any of *Pr.190 to Pr.192* does not turn ON/OFF if 0/1 is set to the terminal bit of *Pr.496*. (It turns ON/OFF with the assigned function.)

Parameter referred to

Pr.190 to Pr.192 (output terminal function selection) Refer to page 144

4.13 Monitor display and monitor output signal

Purpose	Parameter to set		Refer to page
To display motor speed To set speed	Speed display and speed setting	Pr.37, Pr.144	153
To change PU monitor display data	DU/PU main display data selection Cumulative monitor clear	Pr.52, Pr.54, Pr.170, Pr.171, Pr.268, Pr.563, Pr.564	155
To change the monitor output from terminal FM	Terminal FM function selection	Pr.54	155
To set the reference of the monitor output from terminal FM	Terminal FM standard setting	Pr.55, Pr.56	161
To adjust terminal FM outputs	Terminal FM calibration	Pr.900	162

4.13.1 Speed display and speed setting (Pr.37, Pr.144)

The increments of the motor speed and the monitored items displayed on the operation panel and PU (FR-PU07) can be switched among frequency, machine speed, etc.

Parameter number	Name	Initial value		Setting range	Description
37	**Speed display**	0		0	Rotation speed display, setting
				0.01 to 9998 *1	Machine speed at 3000r/min.
144	**Speed setting switchover**	0.75K or lower	110	2, 4, 6, 8, 10, 102, 104, 106, 108, 110	Set the number of motor poles when displaying the frequency.
		1.5K, 2.2K	104		
		3.7K	106		

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 The maximum value of the setting range differs according to the *Pr.1 Maximum setting* and it can be calculated from the following formula.

$$\text{Maximum setting value of } Pr.37 < \frac{16777.215 \times 3000\text{r/min}}{\text{Setting value of } Pr.1 \text{ (r/min)}}$$

Note that the maximum setting value of *Pr.37* is 9998 if the result of the above formula exceeds 9998.

- To display a machine speed, set the machine speed at 3000r/min in *Pr.37*, and set the number of motor poles (2, 4, 6, 8, 10) in *Pr.144*.
  For example, when *Pr.37* = "1000", "1000" is displayed on the speed and set speed monitor when the running speed is 3000r/min. When running speed is 1500r/min, "500" is displayed.
- When the number of motor poles +100 (102, 104, 106, 108, 110) is set in *Pr.144*, values are displayed in motor speed increments. (When *Pr.37* = "0")
- To change the display increments to frequency, set the number of motor poles (10) in *Pr.144*. (When *Pr.37* = "0")
- A combination of the *Pr.37* and *Pr.144* settings determines the monitored item and the setting increment as shown in the table below. (Initial settings are outlined with bold borders)

Pr.37 setting value	*Pr.144* setting value	Output frequency monitor	Set frequency monitor	Frequency setting	Parameter setting
0 (initial value)	2 to 10	0.01Hz	0.01Hz	0.01Hz	0.01Hz
	102 to 110 (initial value)	1r/min *	1r/min *	1r/min *	1r/min *
0.01 to 9998	2 to 10	0.001 (Machine speed *)	0.001 (Machine speed *)	0.001 (Machine speed *)	0.01Hz
	102 to 110	0.01Hz	0.01Hz	0.01Hz	0.01Hz

* Motor speed r/min conversion formula............... frequency × 120/number of motor poles *(Pr.144)*
Machine speed conversion formula.................... *Pr.37* × speed/3000r/min
For *Pr.144* in the above formula, the value is "*Pr.144*-100" when "102 to 110" is set in *Pr.144*.

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PARAMETERS

NOTE

- Refer to *Pr.52* when you want to change the PU main monitor (PU main display)
- Since the panel display of the operation panel is 4 digits in length, the monitor value of more than "9999" is displayed "----".
- When the machine speed is displayed on the FR-PU07, do not change the speed by using an up/down key in the state where the set speed exceeding 65535 is displayed. The set speed may become arbitrary value.
- When the machine speed display is selected, monitored items and speed setting are displayed in machine speed increments, but the values of other parameters related to speed (*Pr.1*, etc.) are in frequency increments. Set other parameters (*Pr.1*, etc) related to speed in increments of frequency.
- Due to the limitations on the resolution of the set frequency, the indication in the second decimal place may differ from the setting.

⚠ CAUTION

⚠ **Make sure that the running speed setting is correct.**
Otherwise, the motor might run at extremely high speed, damaging the machine.

Parameters referred to

Pr.1 Maximum setting *Refer to page 115*
Pr.52 DU/PU main display data selection *Refer to page 155*

4.13.2 Monitor display selection of DU/PU and terminal FM (Pr.52, Pr.54, Pr.170, Pr.171, Pr.268, Pr.430, Pr.563, Pr.564)

The monitor to be displayed on the main screen of the control panel and parameter unit (FR-PU07) can be selected.
In addition, signal to be output from the terminal FM (pulse train output) can be selected.

Parameter number	Name	Initial value	Setting range	Description
52 *	**DU/PU main display data selection**	0 (rotation speed (output frequency))	0, 5, 8 to 12, 14, 19, 20, 23 to 31, 36, 37, 52 to 55, 61, 62, 100	Select the monitor to be displayed on the operation panel and parameter unit. Refer to the following table for monitor description.
54 *	**FM terminal function selection**	1 (rotation speed (output frequency))	1 to 3, 5, 8 to 12, 14, 21, 24, 36, 37, 52, 53, 61, 62	Select the monitor output to terminal FM.
170	**Watt-hour meter clear**	9999	0	Set "0" to clear the watt-hour meter monitor.
			10	Sets the maximum value for the monitoring from communication to 9999kWh.
			9999	Sets the maximum value for the monitoring from communication to 65535kWh.
171	**Operation hour meter clear**	9999	0, 9999	Set "0" in the parameter to clear the operation time monitor. Setting 9999 does not clear.
268 *	**Monitor decimal digits selection**	9999	0	Displayed as integral value
			1	Displayed in 0.1 increments.
			9999	No function
430	**Pulse monitor selection**	9999	4	The lower 4 digits of the droop pulse [after the electronic gear] is displayed.
			5	The upper 4 digits of the droop pulse [after the electronic gear] is displayed.
			100	The lower 4 digits of the position command [before the electronic gear] is displayed.
			101	The upper 4 digits of the position command [before the electronic gear] is displayed.
			102	The lower 4 digits of the current position [before the electronic gear] is displayed.
			103	The upper 4 digits of the current position [before the electronic gear] is displayed.
			104	The lower 4 digits of the droop pulse [before the electronic gear] is displayed.
			105	The upper 4 digits of the droop pulse [before the electronic gear] is displayed.
			9999	The rotation speed (output frequency) monitor is displayed.
563	**Energization time carrying-over times**	0	0 to 65535 (reading only)	The numbers of cumulative energization time monitor exceeded 65535h is displayed. (Reading only)
564	**Operating time carrying-over times**	0	0 to 65535 (reading only)	The numbers of operation time monitor exceeded 65535h is displayed. (Reading only)

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

* This parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*

(1) Monitor description list *(Pr.52)*

- Set the monitor to be displayed on the operation panel and parameter unit (FR-PU07) in *Pr.52 DU/PU main display data selection*.
- Set the monitor to be output to the terminal FM (pulse train output) in *Pr.54 FM terminal function selection*.
- Refer to the following table and set the monitor to be displayed. (The monitor marked × cannot be selected.)

Types of Monitor	Unit	*Pr.52* Setting: Operation Panel LED	*Pr.52* Setting: PU Main Monitor	*Pr.54* (FM) Setting	Terminal FM Full Scale Value	Description
Rotation speed (Output frequency)*1	1r/min (0.01Hz)	0/100		1	*Pr.55*	Displays the drive unit rotation speed (drive unit output frequency)
Output current*10	0.01A	0/100		2	*Pr.56*	Displays the drive unit output current effective value.
Output voltage*10	0.1V	0/100		3	400V	Displays the drive unit output voltage.
Fault display	—	0/100		×	—	Displays 8 past faults individually.
Speed setting (frequency setting value)*1	1r/min (0.01Hz)	5	*2	5	*Pr.55*	Displays the set speed (frequency).
Converter output voltage	0.1V	8	*2	8	400V	Displays the DC bus voltage value.
Regenerative brake duty	0.1%	9	*2	9	*Pr.70*	Brake duty set in *Pr.30, Pr.70*
Electronic thermal relay function load factor	0.1%	10	*2	10	100%	Displays the thermal cumulative value on the assumption that the thermal operation level is 100% (Larger thermal between the motor thermal and transistor thermal). *7
Output current peak value	0.01A	11	*2	11	*Pr.56*	Holds and displays the peak value of the output power monitor. (Cleared at every start)
Converter output voltage peak value	0.1V	12	*2	12	400V	Holds and displays the peak value of the DC bus voltage value. (Cleared at every start)
Output power	0.01kW	14	*2	14	Rated drive unit power × 2	Displays the power on the drive unit output side
Input terminal status	—	—	*2	×	—	Displays the input terminal ON/OFF status on the PU. (*Refer to page 159* for DU display)
Output terminal status	—	—	*2	×	—	Displays the output terminal ON/OFF status on the PU. (*Refer to page 159* for DU display)
Position pulse	—	19		×	—	Displays the position within one revolution of the motor. One revolution of the motor is 5120.
Cumulative energization time *3	1h	20		×	—	Adds up and displays the energization time after drive unit shipment. You can check the numbers of the monitor value exceeded 65535h with *Pr.563*.
Reference voltage output	—	—		21	—	Terminal FM: Output 1440pulse/s
Actual operation time *3, *4	1h	23		×	—	Adds up and displays the drive unit operation time. You can check the numbers of the monitor value exceeded 65535h with *Pr.564*. Can be cleared by *Pr.171*. *(Refer to page 160)*
Motor load factor	0.1%	24		24	200%	Displays the torque in percentage on the assumption that the rated motor torque is 100%. Monitor value = torque / motor rating torque × 100 [%]

Types of Monitor	Unit	*Pr.52* Setting		*Pr.54* (FM) Setting	Terminal FM Full Scale Value	Description
		Operation Panel LED	PU Main Monitor			
Cumulative power *6	0.01kWh *5	25		×	—	Adds up and displays the power amount based on the output power monitor. Can be cleared by *Pr.170*. *(Refer to page 159)*
Position command [before electronic gear] (lower 4 digits) *8	1	26		×	—	Position command [before electronic gear] = position command [before electronic gear] (upper 4 digits) × 10000 + position command [before electronic gear] (lower 4 digits) Without a sign (always displayed as a plus value.)
Position command [before electronic gear] (upper 4 digits) *8	10000 *9	27		×	—	
Current position [before electronic gear] (lower 4 digits) *8	1	28		×	—	Current position [before electronic gear] = current position [before electronic gear] (upper 4 digits) × 10000 + current position [before electronic gear] (lower 4 digits) Without a sign (always displayed as a plus value.)
Current position [before electronic gear] (upper 4 digits) *8	10000 *9	29		×	—	
Droop pulse [after electronic gear] (lower 4 digits) *8	1	30		×	—	Droop pulse [after electronic gear] = droop pulse [after electronic gear] (upper 4 digits) × 10000 + droop pulse [after electronic gear] (lower 4 digits) Without a sign (always displayed as a plus value.)
Droop pulse [after electronic gear] (upper 4 digits) *8	10000 *9	31		×	—	
Ideal speed command	1r/min (0.01Hz)	36		36	*Pr.55*	Displays an ideal speed command for creating a position command.
Speed command	1r/min (0.01Hz)	37		37	*Pr.55*	Displays the speed command after position loop.
PID set point	0.1%	52		52	100%	Displays the set point, measured value and deviation during PID controlPID (*Refer to page 239* for details)
PID measured value	0.1%	53		53	100%	
PID deviation	0.1%	54		×	—	
Drive unit I/O terminal monitor	—	55	×	×	—	Displays the ON/OFF status of the drive unit input terminal and output terminal on the operation panel (*Refer to page 159* for details)
Motor thermal load factor	0.1%	61		61	Thermal relay operation level (100%)	Motor thermal heat cumulative value is displayed. (Motor overload trip (E.THM) at 100%)
Drive unit thermal load factor	0.1%	62		62	Thermal relay operation level (100%)	Transistor thermal heat cumulative value is displayed. (Drive unit overload trip (E.THT) at 100%)

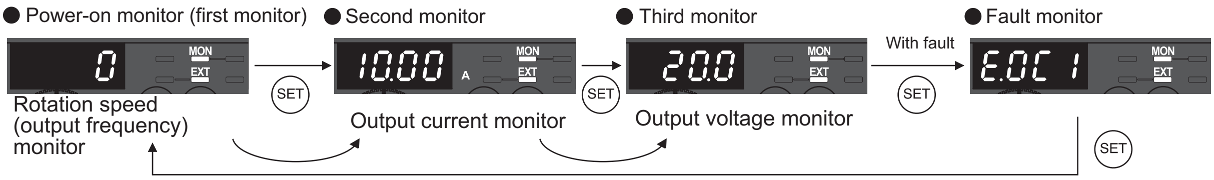
*1 When "102 or higher" is set in *Pr.144 Speed setting switchover*, the speed display is enabled. For "2 to 10", the frequency display is enabled.
*2 Speed setting to output terminal status on the PU main monitor are selected by "other monitor selection" of the parameter unit (FR-PU07).
*3 The cumulative energization time and actual operation time are accumulated from 0 to 65535 hours, then cleared, and accumulated again from 0. When the operation panel is used, the time is displayed up to 65.53 (65530h) in the indication of 1h = 0.001, and thereafter, it is added up from 0.
*4 Actual operation time is not accumulated when the cumulative operation time is less than 1h until turning OFF of the power supply.
*5 When using the parameter unit (FR-PU07), "kW" is displayed.
*6 Since the panel display of the operation panel is 4 digits in length, the monitor value of more than "9999" is displayed "----".
*7 Larger thermal value between the motor thermal and transistor thermal is displayed.
A value other than 0% is displayed if the surrounding air temperature (heatsink temperature) is high even when the drive unit is at a stop.
*8 For the parameter unit (FR-PU07), the display is upper 5 digits or lower 5 digits.
*9 The unit used for the display is 10000.
*10 The monitored values are retained even if an drive unit fault occurs.
Resetting will clear the retained values.

REMARKS

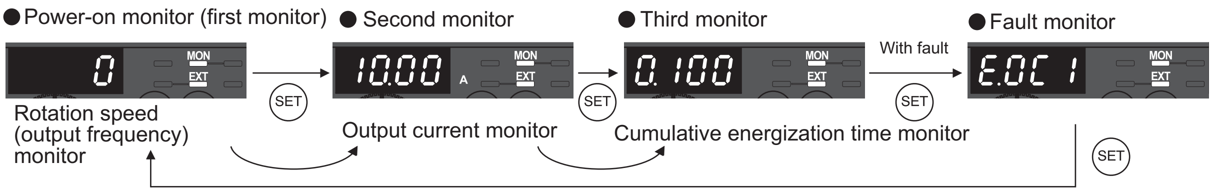
- By setting "0" in *Pr.52*, the monitoring of rotation speed (output frequency) to fault display can be selected in sequence by (SET).
- When the operation panel is used, the displayed units are Hz and A only and the others are not displayed.
- The monitor set in *Pr.52* is displayed in the third monitor position. However, change the output current monitor for the motor load factor.

Initial Value

* The monitor displayed at power-ON is the first monitor. Display the monitor you want to display on the first monitor and hold down (SET) for 1s. (To return to the rotation speed (output frequency) monitor, hold down (SET) for 1s after displaying the rotation speed (output frequency) monitor.)



Example) When *Pr.52* is set to "20" (cumulative energization time), the monitor is displayed on the operation panel as described below.



(2) Display set speed (frequency) during stop *(Pr.52)*

- When "100" is set in *Pr.52*, the set speed (frequency) and rotation speed (output frequency) are displayed during stop and operation respectively. (LED of Hz flickers during stop and is lit during operation.)

	Pr.52		
	0	**100**	
	During running/stop	**During stop**	**During running**
Rotation speed (output frequency)	Rotation speed (output frequency)	Set speed (Set frequency)*	Rotation speed (output frequency)
Output current	Output current		
Output voltage	Output voltage		
Fault display	Fault display		

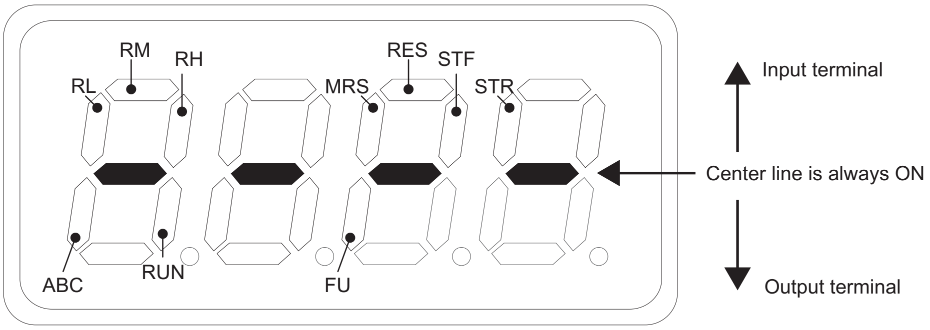
* The set speed (frequency) displayed indicates the speed (frequency) to be output when the start command is ON. Different from the speed (frequency) setting displayed when *Pr.52* = "5", the value based on maximum/minimum frequency and frequency jump is displayed.

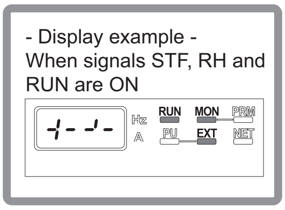
REMARKS

- During an error, the output frequency at error occurrence appears.
- During MRS signal is ON, the values displayed are the same as during a stop.

(3) Operation panel I/O terminal monitor *(Pr.52)*

- When *Pr.52* is set to "55", the I/O terminal status can be monitored on the operation panel.
- The I/O terminal monitor is displayed on the third monitor.
- The LED is ON when the terminal is ON, and the LED is OFF when the terminal is OFF. The center line of LED is always ON.
- On the unit I/O terminal monitor (*Pr.52* = "55"), the upper LEDs denote the input terminal status and the lower the output terminal status.





(4) Cumulative power monitor and clear *(Pr.170)*

- On the cumulative power monitor (*Pr.52* = "25"), the output power monitor value is added up and is updated in 100ms increments. (The values are saved in EEPROM every hour.)
- The operation panel, parameter unit (FR-PU07) and communication (RS-485 communication, communication option) display increments and display ranges are as indicated below.

Operation Panel *1		Parameter Unit *2		Communication		
Range	Unit	Range	Unit	Range		Unit
				Pr.170 = 10	*Pr.170* = 9999	
0 to 99.99kWh	0.01kWh	0 to 999.99kWh	0.01kWh	0 to 9999kWh	0 to 65535kWh (initial value)	1kWh
100.0 to 999.9kWh	0.1kWh	1000.0 to 9999.9kWh	0.1kWh			
1000 to 9999kWh	1kWh	10000 to 99999kWh	1kWh			

*1 Power is measured in the range 0 to 9999.99kWh, and displayed in 4 digits.
When the monitor value exceeds "99.99", a carry occurs, e.g. "100.0", so the value is displayed in 0.1kWh increments.

*2 Power is measured in the range 0 to 99999.99kWh, and displayed in 5 digits.
When the monitor value exceeds "999.99", a carry occurs, e.g. "1000.0", so the value is displayed in 0.1kWh increments.

- Writing "0" to *Pr.170* clears the cumulative power monitor.

REMARKS

- If "0" is written to *Pr.170* and *Pr.170* is read again, "9999" or "10" is displayed.

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(5) Cumulative energization time and actual operation time monitor *(Pr.171, Pr.563, Pr.564)*

- Cumulative energization time monitor (*Pr.52* = "20") accumulates energization time from shipment of the drive unit every one hour.
- On the actual operation time monitor (*Pr.52* = "23"), the drive unit running time is added up every hour. (Time is not added up during a stop.)
- If the monitored value exceeds 65535, it is added up from 0. You can check the numbers of cumulative energization time monitor exceeded 65535h with *Pr.563* and the numbers of actual operation time monitor exceeded 65535h with *Pr.564*.
- Writing "0" to *Pr.171* clears the cumulative power monitor. (The cumulative time monitor can not be cleared.)

REMARKS

- The cumulative energization time does not increase if the power is ON for less than an hour.
- The actual operation time does not increase if the cumulative running time during power-ON status is less than an hour.
- If "0" is written to *Pr.171* and *Pr.171* is read again, "9999" is always displayed. Setting "9999" does not clear the actual operation time meter.

(6) You can select the decimal digits of the monitor *(Pr.268)*

- As the operation panel display is 4 digits long, the decimal places may vary at analog input, etc. The decimal places can be hidden by selecting the decimal digits.
  In such a case, the decimal digits can be selected by *Pr.268*.

Pr.268 Setting	Description
9999 (initial value)	No function
0	For the first or second decimal places (0.1 increments or 0.01 increments) of the monitor, numbers in the first decimal place and smaller are rounded to display an integral value (1 increments). The monitor value smaller than 0.99 is displayed as 0.
1	When 2 decimal places (0.01 increments) are monitored, the 0.01 decimal place is dropped and the monitor displays the first decimal place (0.1 increments). The monitored digits in 1 increments are displayed as they are.

REMARKS

- The number of display digits on the cumulative energization time (*Pr.52* = "20"), actual operation time (*Pr.52* = "23"), and cumulative power (*Pr.52* = "25") does not change.

(7) Position monitor selection *(Pr.430)*

- The monitor set in *Pr.430* is displayed in the first monitor (rotation speed monitor) position.
  The value is displayed without a sign (always displayed as a plus value).
  For the parameter unit (FR-PU07), the display is upper 5 digits or lower 5 digits.
- When reading the rotation speed monitor via the RS-485 communication or CC-Link communication is set, the position monitor is available.

Parameters referred to

Pr.30 Regenerative function selection, Pr.70 Special regenerative brake duty ☞ Refer to page 136
Pr.37 Speed display ☞ Refer to page 153
Pr.55 Speed monitoring reference, Pr.56 Current monitoring reference ☞ Refer to page 161

4.13.3 Reference of the terminal FM (pulse train output) (Pr.55, Pr.56)

The pulse train output terminal FM is available for monitor output.
Set the reference of the signal output from terminal FM.

Parameter number	Name	Initial value	Setting range	Description
55*1	**Speed monitoring reference**	3000r/min	0 to 4800r/min*2	Full-scale value when speed monitor value is output to terminal FM.
56*1	**Current monitoring reference**	Motor rated current*3	0 to 500A	Full-scale value when current monitor value is output to terminal FM.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

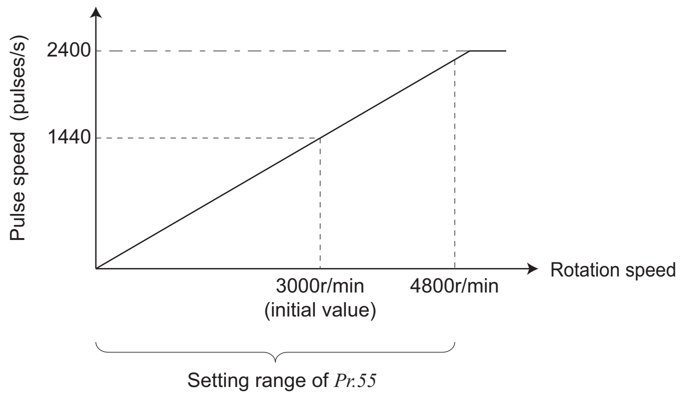
*1 The above parameters allow their settings to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

*2 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

*3 The setting differs according to the drive unit capacity. (0.75K or lower: rated current of MM-GKR motor (*Refer to page 307.*), 1.5K or higher: rated current of S-PM geared motor (*Refer to page 310.*))

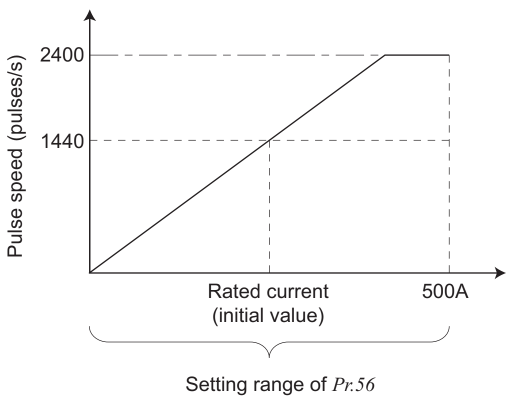
(1) Speed monitoring reference *(Pr.55)*

- Set the full scale value when outputting the speed monitor from terminal FM.
- Set the speed to be indicated as the full scale value on the speed meter (1mA analog meter) connected between terminal FM and SD.
- Set the speed at which the pulse speed of the FM output is 1440 pulses/s.
- The pulse speed and rotation speed are proportional to each other. (The maximum pulse train output is 2400 pulses/s.)



(2) Current monitoring reference *(Pr.56)*

- Set the full scale value when outputting the current monitor from terminal FM.
- Set the output current at which the pulse speed of the FM output is 1440 pulses/s.
- The pulse speed and output current monitor value are proportional to each other. (The maximum pulse train output is 2400 pulses/s.)



4.13.4 Terminal FM calibration (calibration parameter C0 (Pr.900))

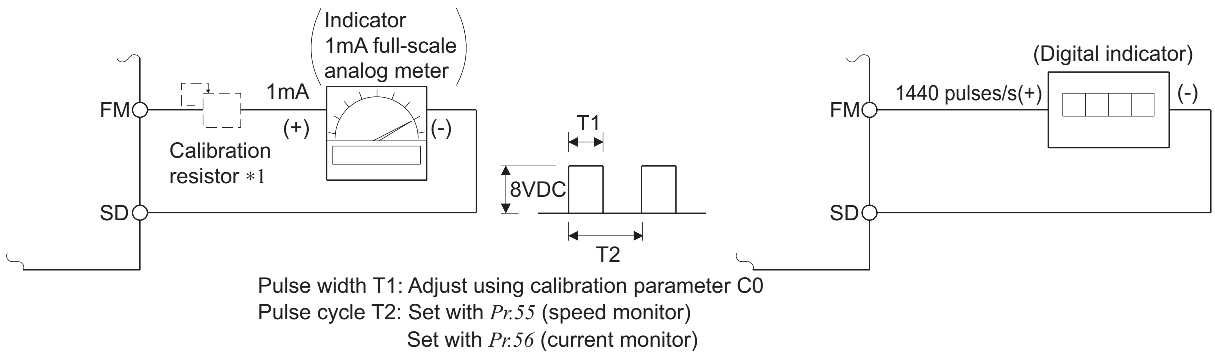
By using the operation panel or parameter unit, you can calibrate terminal FM to full scale deflection.

Parameter number	Name	Initial value	Setting range	Description
C0 (900)	**FM terminal calibration**	—	—	Calibrates the scale of the meter connected to terminal FM.

∗1 The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
∗2 The parameter number in parentheses is the one for use with parameter unit (FR-PU07).
∗3 The above parameters allow their settings to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

(1) FM terminal calibration *(C0 (Pr.900))*

- The terminal FM is preset to output pulses. By setting the *FM terminal calibration C0 (Pr.900)*, the meter connected to the drive unit can be calibrated by parameter setting without use of a calibration resistor.
- Using the pulse train output of the terminal FM, a digital display can be provided to connect a digital counter. The monitor value is 1440 pulses/s output at the full-scale value of monitor description list *(page 156) (Pr.54 FM terminal function selection)*.



∗1 Not needed when the operation panel or parameter unit (FR-PU07) is used for calibration.
Use a calibration resistor when the indicator (speed meter) needs to be calibrated by a neighboring device because the indicator is located far from the drive unit. However, the speed meter needle may not deflect to full-scale if the calibration resistor is connected. In this case, perform calibration using the operation panel or parameter unit.
∗2 The default settings are 1mA full-scale and 1440 pulses/s terminal FM speed at 3000r/min.

- Calibrate the terminal FM in the following procedure.
  1) Connect an indicator (speed meter) across terminals FM-SD of the drive unit. (Note the polarity. The terminal FM is positive)
  2) When a calibration resistor has already been connected, adjust the resistance to "0" or remove the resistor.
  3) Refer to the monitor description list *(page 156)* and set *Pr.54*.
     When you selected the running speed or drive unit output current as monitor, preset the running speed or current value, at which the output signal will be 1440 pulses/s, to *Pr.55 Speed monitoring reference* or *Pr.56 Current monitoring reference*.
     At 1440 pulses/s, the meter generally deflects to full-scale.

REMARKS

- When calibrating a monitor output signal, which cannot be adjusted to 100% value without an actual load and a measurement equipment, set *Pr.54* to "21" (reference voltage output). 1440 pulses/s are output from the terminal FM.
- The wiring length of the terminal FM should be 200m maximum.

NOTE

- **The initial value of the *calibration parameter C0 (Pr.900)* is set to 1mA full-scale and 1440 pulses/s terminal FM pulse train output at 3000r/min. The maximum pulse train output of terminal FM is 2400 pulses/s.**

(2) How to calibrate the terminal FM when using the operation panel

Operation	Display
	(When *Pr.54* = 1)
1. Confirmation of the operation status indicator and operation mode indicator	0 MON PU
2. Press MODE to choose the parameter setting mode.	MODE ⇨ P. 1 PRM PRM indicator is lit. (The parameter number read previously appears.)
3. Turn the setting dial until C... appears.	⇨ C...
4. Press SET to display C---.	SET ⇨ C--- (*C0 to C7* setting is enabled.)
5. Turn the setting dial until C 0 appears. Set to *C0 FM terminal calibration*.	⇨ C 0
6. Press SET to enable setting.	SET ⇨ 0 (The monitor set to *Pr. 54 FM terminal function selection* is displayed.)
7. If the drive unit is at a stop, press the RUN key to start the drive unit.	RUN ⇨ 0 MON PU
8. Turn the setting dial to adjust the indicator needle to the desired position.	+ − ⇨  Analog indicator
9. Press SET. Setting is complete.	SET ⇨ 3000 ↔ C 0

Flicker...Parameter setting complete!!

- Turn the setting dial to read another parameter.
- Press SET to return to the C--- indication (step 4).
- Press SET twice to show the next parameter (Pr.CL).

REMARKS

- Calibration can also be made for external operation. Set the speed in the External operation mode, and make calibration in the above procedure.
- Calibration can be made even during operation.
- For operation from the parameter unit (FR-PU07), refer to the instruction manual of the parameter unit.

Parameters referred to

Pr.54 FM terminal function selection ☞ *Refer to page 155*
Pr.55 Speed monitoring reference ☞ *Refer to page 161*
Pr.56 Current monitoring reference ☞ *Refer to page 161*

4.14 Operation setting at fault occurrence

Purpose	Parameter to set		Refer to page
To recover by retry operation at fault occurrence	Retry operation	Pr.65, Pr.67 to Pr.69	*164*
To disable output input/output phase loss alarm	Input/output phase failure protection selection	Pr.251, Pr.872	*166*
To detect an earth (ground) fault at start	Earth (ground) fault detection at start	Pr.249	*166*
To detect motor overspeed	Overspeed detection level	Pr.374	*167*

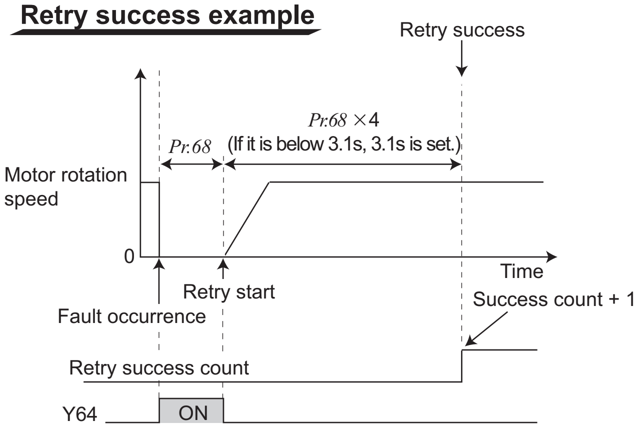
4.14.1 Retry function (Pr.65, Pr.67 to Pr.69)

If a fault occurs, the drive unit resets itself automatically to restart. You can also select the fault for a retry.

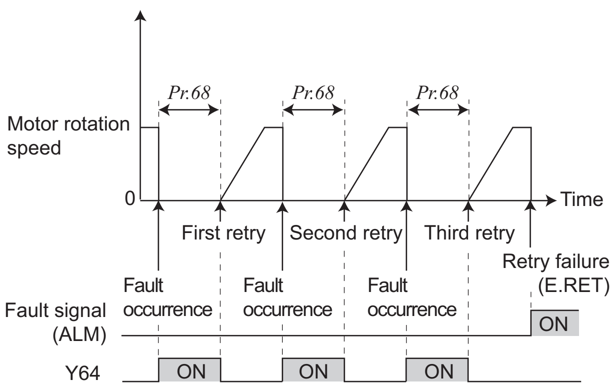
Parameter number	Name	Initial value	Setting range	Description
65	Retry selection	0	0 to 5	A fault for retry can be selected. *(Refer to the next page)*
67	Number of retries at fault occurrence	0	0	No retry function
			1 to 10	Set the number of retries at fault occurrence. A fault output is not provided during retry operation.
			101 to 110	Set the number of retries at fault occurrence. (The setting value of minus 100 is the number of retries.) A fault output is provided during retry operation.
68	Retry waiting time	1s	0.1 to 360s	Set the waiting time from when a drive unit fault occurs until a retry is made.
69	Retry count display erase	0	0	Clear the number of restarts succeeded by retry.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

Retry success example



Retry failure example



- Retry operation automatically resets a fault and restarts the drive unit at the starting speed when the time set in *Pr.68* elapses after the drive unit is tripped.
- Retry operation is performed by setting *Pr.67* to any value other than "0". Set the number of retries at fault occurrence in *Pr.67*.
- When retries fail consecutively more than the number of times set in *Pr.67*, a retry count excess fault (E.RET) occurs, resulting in drive unit trip. (Refer to retry failure example)
- Use *Pr.68* to set the waiting time from when the drive unit trips until a retry is made in the range 0.1 to 360s.
- Reading the *Pr.69* value provides the cumulative number of successful restart times made by retry.
  The cumulative count in *Pr.69* is increased by 1 when a retry is regarded as successful after normal operation continues without faults occurring for more than four times longer than the time (3.1s at shortest) set in *Pr.68* after a retry start. (When retry is successful, cumulative number of retry failure is cleared.)
- Writing "0" to *Pr.69* clears the cumulative count.
- During a retry, the Y64 signal is ON. For the Y64 signal, assign the function by setting "64 (positive operation)" or "164 (negative operation)" to any of *Pr.190 to Pr.192 (output terminal function selection)*.

- Using *Pr.65*, you can select the fault that will cause a retry to be executed. No retry will be made for the fault not indicated. (*Refer to page 268* for the fault description.)
  ● indicates the faults selected for retry.

Fault for Retry	*Pr.65* Setting					
	0	1	2	3	4	5
E.OC1	●	●		●	●	●
E.OC2	●	●		●	●	
E.OC3	●	●		●	●	●
E.OV1	●		●	●	●	
E.OV2	●		●	●	●	
E.OV3	●		●	●	●	
E.THM	●					
E.THT	●					
E. BE	●				●	
E. GF	●				●	
E.USB	●				●	

Fault for Retry	*Pr.65* Setting					
	0	1	2	3	4	5
E.OS	●				●	
E.OSD	●				●	
E.OA	●				●	
E.OHT	●					
E.OLT	●				●	
E.OPT	●				●	
E.OP1	●				●	
E. PE	●				●	
E.ILF	●				●	
E.SOT	●	●		●	●	●

NOTE

- **Use the retry function only when the operation can be resumed after resetting a protective function activation. Making a retry against the protective function, which is activated by an unknown condition, will lead the drive unit and motor to be faulty. Identify in what condition the protective function was activated, and eliminate such condition before resuming the operation.**
- **When terminal assignment is changed using *Pr.190 to Pr.192*, the other functions may be affected. Set parameters after confirming the function of each terminal.**
- **The data stored as the error reset for retry is only that of the fault which occurred the first time.**
- **When a drive unit fault is reset by the retry function at the retry time, the accumulated data of the electronic thermal relay function, regeneration brake duty etc. are not cleared. (Different from the power-ON reset.)**
- **Retry is not performed if E.PE (Parameter storage device fault) occurred at power ON.**
- **If a fault that is not selected for a retry occurs during retry operation (retry waiting time), the retry operation stops while the fault indication is still displayed.**
- **Under position control, the retry function is disabled.**

⚠ CAUTION

⚠ **When you have selected the retry function, stay away from the motor and machine when the drive unit is tripped. They will start suddenly (after the reset time has elapsed) after the drive unit trip.**
When you have selected the retry function, apply in easily visible places the CAUTION stickers supplied.

Parameter referred to

Pr.190 to Pr.192 (output terminal function selection) ☞ *Refer to page 144*

4.14.2 Input/output phase loss protection selection (Pr.251, Pr.872)

You can choose whether to use Input/output phase loss protection or not.

- Output phase loss protection is a function to stop the drive unit output if one of the three phases (U, V, W) on the drive unit's output side (load side) is lost.
- Input phase loss protection is a function to stop the drive unit output if one of the three phases (R/L1, S/L2, T/L3) on the drive unit's input side is lost.

Parameter number	Name	Initial value	Setting range	Description
251	**Output phase loss protection selection**	1	0	Without output phase loss protection
			1	With output phase loss protection
872	**Input phase loss protection selection**	0	0	Without input phase loss protection
			1	With input phase loss protection

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Output phase loss protection selection *(Pr.251)*

- If a phase loss occurs during drive unit operation (except for during zero speed control, or 12r/min or less rotation speed), the output phase loss protection (E.LF) is activated, and drive unit trips.
- When *Pr.251* is set to "0", output phase loss protection (E.LF) becomes invalid.

(2) Input phase loss protection selection *(Pr.872)*

- When *Pr.872* is set to "1", input phase loss protection (E.ILF) is provided if a phase loss of one phase among the three phases is detected for 1s continuously.

NOTE

- **If an input phase loss under high load continues for a long time, the converter section and capacitor lives of the drive unit will be shorter.**
- **If the load is light or during a stop, lost phase cannot be detected because input phase loss detection is performed based on the fluctuation of bus voltage.**
  During the S-PM geared motor driving operation, lost phase cannot be detected because the drive unit has a one-rank higher capacity compared to the motor, and the load is light for the drive unit capacity. When the load exceeds the rated output, however, phase loss detection may be performed.
- **Phase loss can not be detected during regeneration load operation.**

4.14.3 Earth (ground) fault detection at start (Pr.249)

You can choose whether to use earth (ground) fault detection at start or not. Earth (Ground) fault detection is executed only right after the start signal is input to the drive unit.
Protective function will not activate if an earth (ground) fault occurs during operation.

Parameter number	Name	Initial value	Setting range	Description
249	**Earth (ground) fault detection at start**	0	0	Without earth (ground) fault detection
			1	With earth (ground) fault detection

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

NOTE

- As detection is executed at start, output is delayed for approx. 20ms every start. (The time required for magnetic pole detection at start is also added to the output delay time.)
- If an earth (ground) fault is detected with "1" set in *Pr.249*, output side earth (ground) fault overcurrent (E.GF) is detected and the drive unit trips. *(Refer to page 275)* Even when a ground fault occurs, however, an overcurrent (E.OC3) may be detected first to result in the output shutoff.

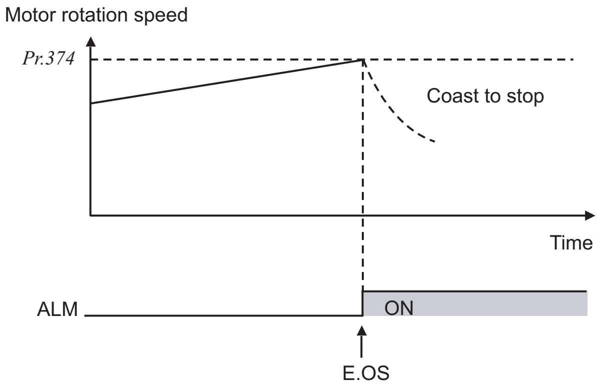
4.14.4 Overspeed detection (Pr.374)

The drive unit output can be shut off in case of overspeed.

Parameter number	Name	Initial value	Setting range	Description
374	**Overspeed detection level**	3450r/min	0 to 4800r/min*1	When the motor speed reaches or exceeds the speed set in *Pr.374*, overspeed (E.OS) occurs, and the drive unit outputs is stopped.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

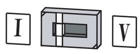
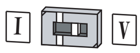


4.15 Speed setting by analog input (terminal 2, 4)

Purpose	Parameter to set		Refer to page
To select voltage/current input (terminal 2, 4) **To perform forward/reverse rotation by analog input**	**Analog input selection**	**Pr.73, Pr.267**	*168*
To adjust (calibrate) analog input speed and voltage (current)	**Bias and gain of speed setting voltage (current)**	**Pr.125, Pr.126, Pr.241, C2 to C7 (Pr.902 to Pr.905)**	*173*

4.15.1 Analog input selection (Pr.73, Pr.267)

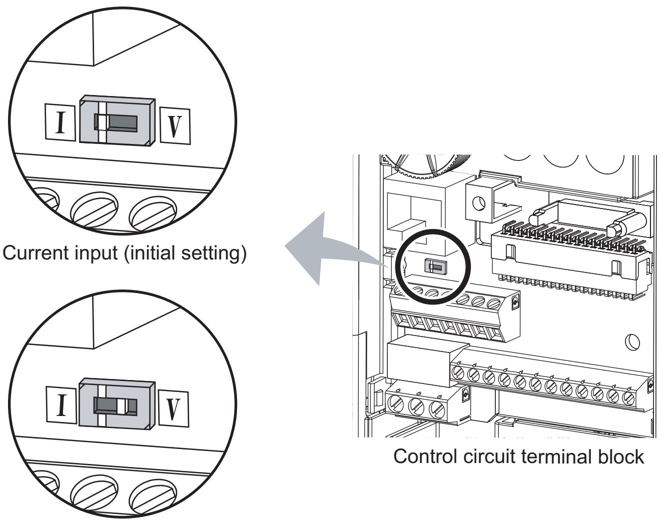
You can select the function that switches between forward rotation and reverse rotation according to the analog input terminal specifications and input signal.

Parameter number	Name	Initial value	Setting range	Description	
73	**Analog input selection**	1	0	Terminal 2 input 0 to 10V	Without reversible operation
			1	Terminal 2 input 0 to 5V	
			10	Terminal 2 input 0 to 10V	With reversible operation
			11	Terminal 2 input 0 to 5V	
267	**Terminal 4 input selection**	0		**Voltage/current input switch**	**Description**
			0		Terminal 4 input 4 to 20mA
			1		Terminal 4 input 0 to 5V
			2		Terminal 4 input 0 to 10V

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Selection of analog input specifications

- For the terminal 2 for analog voltage input, 0 to 5V (initial value) or 0 to 10V can be selected.
- Either voltage input (0 to 5V, 0 to 10V) or current input (4 to 20mA initial value) can be selected for terminal 4 used for analog input.
  Change the input specifications to change *Pr.267* and voltage/current input switch.
- Rated specifications of terminal 4 change according to the voltage/current input switch setting.
  Voltage input: Input resistance 10kΩ ± 1kΩ, maximum permissible input voltage 20VDC
  Current input: Input resistance 233Ω ± 5Ω, maximum permissible input voltage 30mA



NOTE

- **Set *Pr.267* and a voltage/current input switch correctly, then input an analog signal in accordance with the setting. Incorrect setting as in the table below could cause component damage. Incorrect settings other than below can cause abnormal operation.**

Setting Causing Component Damage		Operation
Switch Setting	Terminal Input	
I (current input)	Voltage input	This could cause component damage to the analog signal output circuit of signal output devices. (electrical load in the analog signal output circuit of signal output devices increases)
V (voltage input)	Current input	This could cause component damage of the drive unit signal input circuit. (output power in the analog signal output circuit of signal output devices increases)

- Refer to the following table and set *Pr.73* and *Pr.267*.
  ([shaded box] indicates main speed setting)

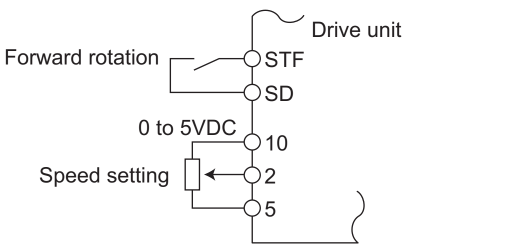
Pr.73 Setting	Terminal 2 Input	Terminal 4 Input		Reversible Operation
		AU signal		
0	0 to 10V	OFF	—	Not function
1 (initial value)	0 to 5V			
10	0 to 10V			Yes
11	0 to 5V			
0	—	ON	According to the *Pr.267* setting 0:4 to 20mA (initial value) 1:0 to 5V 2:0 to 10V	Not function
1 (initial value)				
10				Yes
11				

— : invalid

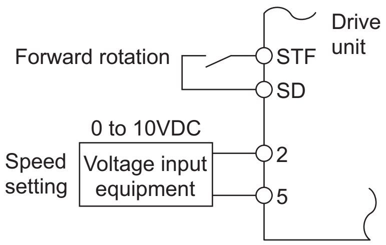
- The terminal used for the AU signal input, set "4" in *Pr.178 to Pr.184 (input terminal function selection)* to assign functions.

NOTE

- **Turn the AU signal ON to make terminal 4 valid.**
- **Make sure that the parameter and switch settings are the same. Different setting may cause a fault, failure or malfunction.**
- **Use *Pr.125 (Pr.126) (speed setting gain)* to change the maximum rotation speed at input of the maximum rotation speed command voltage (current). At this time, the command voltage (current) need not be input.**
  Also, the acceleration/deceleration time, which is a slope up/down to the acceleration/deceleration reference speed, is not affected by the change in *Pr.73* setting.
- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**



Connection diagram using terminal 2 (0 to 5VDC)



Connection diagram using terminal 2 (0 to 10VDC)

(2) Perform operation by analog input selection.

- The speed setting signal inputs 0 to 5VDC (or 0 to 10VDC) to across the terminals 2-5. The 5V (10V) input is the maximum rotation speed.
- The power supply 5V can be input by either using the internal power supply or preparing an external power supply. Prepare an external power supply to input the power supply 10V. For the built-in power supply, terminals 10-5 provide 5VDC output.

Terminal	Drive unit Built-in Power Supply Voltage	Speed Setting Resolution	*Pr.73* (terminal 2 input power)
10	5VDC	6r/min / 3000r/min	0 to 5VDC input

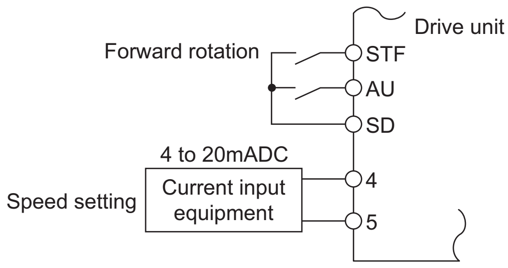
- When inputting 10VDC to the terminal 2, set "0" or "10" in *Pr.73*. (The initial value is 0 to 5V)
- Setting "1 (0 to 5VDC)" or "2 (0 to 10VDC)" in *Pr.267* and a voltage/current input switch in the OFF position changes the terminal 4 to the voltage input specification. When the AU signal turns ON, the terminal 4 input becomes valid.

REMARKS

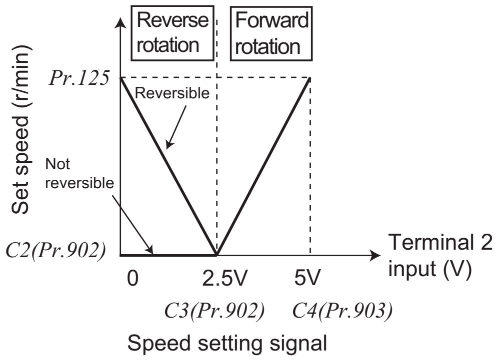
The wiring length of the terminal 10, 2, 5 should be 30m maximum.

4

PARAMETERS



Connection diagram using terminal 4 (4 to 20mADC)



Reversible operation example

(3) Perform operation by analog input selection

- Operation can be performed by inputting the output signal 4 to 20mADC of the adjuster to across the terminals 4-5.
- The AU signal must be turned ON to use the terminal 4.

(4) Perform forward/reverse rotation by analog input (polarity reversible operation)

- Setting "10" or "11" in *Pr.73* and adjusting *Pr.125 (Pr.126) Terminal 2 speed setting gain speed (Terminal 4 speed setting gain speed)* and *C2 (Pr.902) Terminal 2 speed setting bias speed to C7 (Pr.905) Terminal 4 speed setting gain* makes reverse operation by terminal 2 (terminal 4) valid.

Example) When performing reversible operation by terminal 2 (0 to 5V) input

1) Set "11" in *Pr.73* to make reversible operation valid.
   Set speed at maximum analog input in *Pr.125 (Pr.903)*
2) Set 1/2 of the value set in *C4 (Pr.903)* in *C3 (Pr.902)*.
3) Reversible operation is performed when 0 to 2.5VDC is input and forward rotation when 2.5 to 5VDC.

NOTE

- **When reversible operation is set, be aware of reverse rotation operation when analog input stops (only the start signal is input).**
- **When reversible operation is valid, reversible operation (0 to 4mA: reverse operation, 4mA to 20mA: forward operation) is performed by terminal 4 in the initial setting.**
- **Under position control, operation by analog inputs is unavailable.**

Parameters referred to

Pr.125 Terminal 2 speed setting gain speed, Pr.126 Terminal 4 speed setting gain speed ☞ *Refer to page 173*

C2(Pr.902) Terminal 2 speed setting bias speed to C7(Pr.905) Terminal 4 speed setting gain ☞ *Refer to page 173*

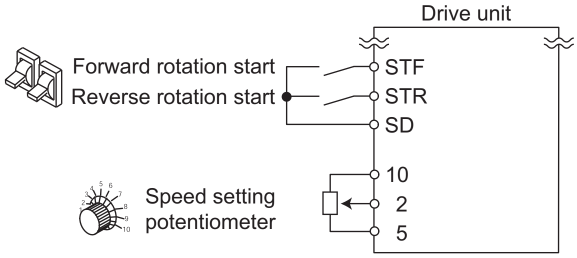
4.15.2 Setting the speed by analog input (voltage input/current input)

POINT

- Turn ON the STF(STR) signal to give a start command.
- Use the potentiometer (speed setting potentiometer) (voltage input) or 4-to-20mA input (current input) to give a speed command.

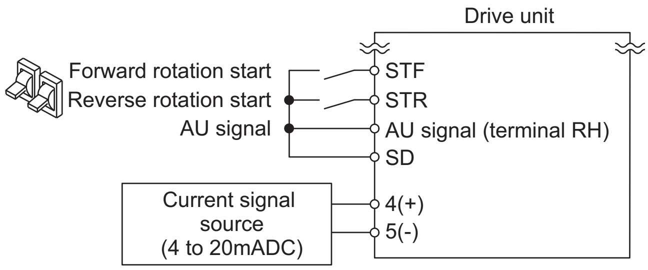
[Connection example for voltage input]

The drive unit supplies 5V power to the speed setting potentiometer. (terminal 10)



[Connection example for current input]

Assign the AU signal in any of *Pr.178 to Pr.184*.



Operation example	Operate at 3000r/min.

Operation — **Display**

1. Screen at power-ON

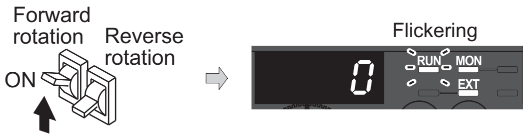
   The monitor display appears.

2. Assignment of the AU signal (current input)

   (Refer to the step 3 for voltage input.)
   Set *Pr.160* to "0" to activate extended parameters.
   To assign the AU signal, set "4" in one of *Pr.178 to Pr.184*. (*Refer to page 51* to change the setting.)
   Turn ON the AU signal.

3. Start

   Turn the start switch (STF or STR) ON.
   The zero speed (0r/min) operation is performed as no speed command is given.
   [RUN] indicator is ON during forward rotation operation and flickers slowly during reverse rotation operation.

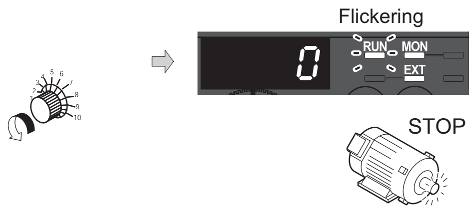


4. Acceleration → constant speed

   For voltage input, turn the potentiometer (speed setting potentiometer) clockwise slowly to full.
   For current input, input 20mA.
   The speed value on the display increases in *Pr.7 Acceleration time*, and " 3000 " (3000r/min) appears.
   [RUN] indicator is ON during forward rotation operation and flickers slowly during reverse rotation operation.

5. Deceleration

   For voltage input, turn the potentiometer (speed setting potentiometer) counterclockwise slowly to full.
   For current input, input 4mA.
   The speed value on the display decreases in *Pr.8 Deceleration time*, and the zero speed (0r/min) operation is performed as no speed command is given.
   [RUN] indicator is ON during forward rotation operation and flickers slowly during reverse rotation operation.



6. Stop

   Turn the start switch (STF or STR) OFF.
   [RUN] turns OFF.

4 PARAMETERS

REMARKS

Pr.178 STF terminal function selection must be set to "60" (or *Pr.179 STR terminal function selection* must be set to "61"). (all are initial values)

?The motor will not rotate ... Why?

☞Check that [EXT] is ON.
[EXT] is valid when *Pr.79* = "0" (initial value) and "2".

Use PU/EXT to ON [EXT].

☞Check that wiring is correct. Check once again.

?Change the speed (0r/min) of the minimum value of potentiometer (at 0V initial value)

☞Adjust the speed in *calibration parameter C2 Terminal 2 speed setting bias speed*. *(Refer to page 173)*

4.15.3 Response level of analog input and noise elimination (Pr.74)

The time constant of the primary delay filter can be set for the external speed command (analog input (terminal 2, 4) signal).

Parameter number	Name	Initial value	Setting range	Description
74	**Input filter time constant**	1	0 to 8	Primary delay filter time constant for the analog input. A larger setting results in a larger filter.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

- Valid for eliminating noise of the speed setting circuit.
- Increase the filter time constant if steady operation cannot be performed due to noise.
  A larger setting results in slower response. (The time constant can be set between approximately 5ms to 1s with the setting of 0 to 8.)

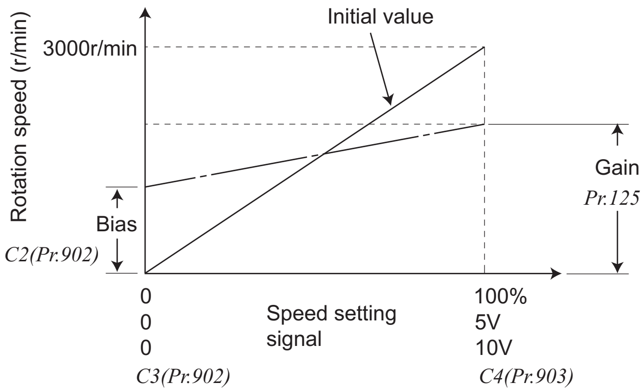
4.15.4 Bias and gain of speed setting voltage (current) (Pr.125, Pr.126, Pr.241, C2 (Pr.902) to C7 (Pr.905))

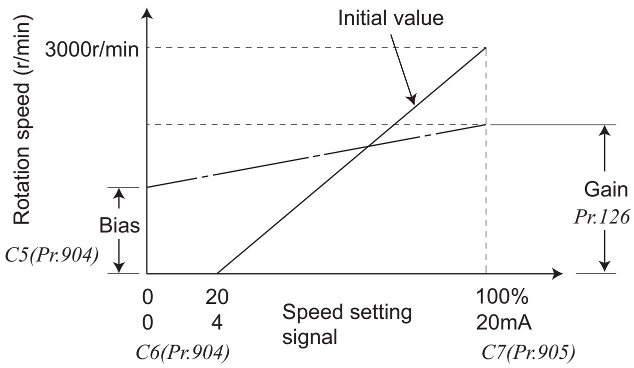
You can set the magnitude (slope) of the rotation speed as desired in relation to the speed setting signal (0 to 5V, 0 to 10V or 4 to 20mADC).
Set *Pr.267* and voltage/current input switch to switch between 0 to 5VDC, 0 to 10VDC, 0 to 20mADC using terminal 4. *(Refer to page 168)*

[Speed setting bias/gain parameter]

<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th colspan="2">Description</th></tr>
<tr><td>125</td><td>Terminal 2 speed setting gain speed</td><td>3000r/min</td><td>0 to 4800r/min *4</td><td colspan="2">Speed of terminal 2 input gain (maximum).</td></tr>
<tr><td>126</td><td>Terminal 4 speed setting gain speed</td><td>3000r/min</td><td>0 to 4800r/min *4</td><td colspan="2">Speed of terminal 4 input gain (maximum).</td></tr>
<tr><td rowspan="2">241 *1, *3</td><td rowspan="2">Analog input display unit switchover</td><td rowspan="2">0</td><td>0</td><td>Displayed in %</td><td rowspan="2">Unit for analog input display.</td></tr>
<tr><td>1</td><td>Displayed in V/mA</td></tr>
<tr><td>C2(902) *1, *2</td><td>Terminal 2 speed setting bias speed</td><td>0r/min</td><td>0 to 4800r/min *4</td><td colspan="2">Speed on the bias side of terminal 2 input.</td></tr>
<tr><td>C3(902) *1, *2</td><td>Terminal 2 speed setting bias</td><td>0%</td><td>0 to 300%</td><td colspan="2">Converted % of the bias side voltage of terminal 2 input.</td></tr>
<tr><td>C4(903) *1, *2</td><td>Terminal 2 speed setting gain</td><td>100%</td><td>0 to 300%</td><td colspan="2">Converted % of the gain side voltage of terminal 2 input.</td></tr>
<tr><td>C5(904) *1, *2</td><td>Terminal 4 speed setting bias speed</td><td>0r/min</td><td>0 to 4800r/min *4</td><td colspan="2">Speed on the bias side of terminal 4 input.</td></tr>
<tr><td>C6(904) *1, *2</td><td>Terminal 4 speed setting bias</td><td>20%</td><td>0 to 300%</td><td colspan="2">Converted % of the bias side current (voltage) of terminal 4 input.</td></tr>
<tr><td>C7(905) *1, *2</td><td>Terminal 4 speed setting gain</td><td>100%</td><td>0 to 300%</td><td colspan="2">Converted % of the gain side current (voltage) of terminal 4 input.</td></tr>
</table>

*1 This parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
*2 The parameter number in parentheses is the one for use with parameter unit (FR-PU07).
*3 This parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.
*4 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)





(1) Change the speed at maximum analog input *(Pr.125, Pr.126)*

- Set *Pr.125 (Pr.126)* when changing speed setting (gain) of the maximum analog input voltage (current) only. (*C2 (Pr.902) to C7 (Pr.905)* setting need not be changed)

(2) Analog input bias/gain calibration *(C2 (Pr.902) to C7 (Pr.905))*

- The "bias" and "gain" functions are used to adjust the relationship between the input signal entered from outside the drive unit to set the rotation speed, e.g. 0 to 5V, 0 to 10V or 4 to 20mADC, and the output frequency.
- Set the bias frequency of the terminal 2 input using *C2 (Pr.902)*.
  (It is initially-set to the speed at 0V)
- Set the rotation speed in *Pr.125* for the speed command voltage set with *Pr.73 Analog input selection*.
- Set the bias speed of the terminal 4 input using *C5 (Pr.904)*.
  (It is initially-set to the speed at 4mA)
- Using *Pr.126*, set the rotation speed relative to 20mA of the speed command current (4 to 20mA).
- There are three methods to adjust the speed setting voltage (current) bias/gain.
  (a) Method to adjust any point by application of a voltage (current) across terminals 2-5 (4-5) ☞*page 175*
  (b) Method to adjust any point without application of a voltage (current) across terminals 2-5 (4-5) ☞*page 176*
  (c) Method to adjust speed only without adjustment of voltage (current) ☞*page 177*

NOTE

- **When voltage/current input signal for terminal 4 was switched using *Pr.267* and voltage/current input switch, perform calibration without fail.**

(3) Analog input display unit changing *(Pr.241)*

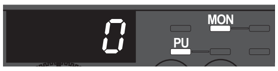
- You can change the analog input display unit (%/V/mA) for analog input bias/gain calibration.
- Depending on the terminal input specification set to *Pr.73, Pr.267*, and voltage/current switch, the display units of *C3 (Pr.902), C4 (Pr.903), C6 (Pr.904), C7 (Pr.905)* change as shown below.

Analog command (terminal 2, 4) (depending on *Pr.73*, *Pr.267*, and voltage/ current input switch)	*Pr.241* = "0 (initial value)"	*Pr.241* = "1"
0 to 5V input	0 to 5V → 0 to 100% (0.1%) display	0 to 100% → 0 to 5V (0.01V) display
0 to 10V input	0 to 10V → 0 to 100% (0.1%) display	0 to 100% → 0 to 10V (0.01V) display
0 to 20mA input	0 to 20mA → 0 to 100%(0.1%) display	0 to 100% → 0 to 20mA (0.01mA) display

(4) Speed setting signal (current) bias/gain adjustment method

Follow the following procedure to adjust the bias and gain of the speed setting voltage (current) using the operation panel. *Refer to page 173* for the details of parameters.

(a) Method to adjust any point by application of a voltage (current) across terminals 2 and 5 (4 and 5).

Operation	Display
1. Confirm the operation status indicator and operation mode indicator ●The drive unit should be at a stop. ●The drive unit should be in the PU operation mode. (Using PU/EXT)	
2. Press MODE to choose the parameter setting mode.	MODE ⇨ PRM indicator is lit.  (The parameter number read previously appears.)
3. Turn the setting dial until C. . . appears.	
4. Press SET to display C - - - .	SET ⇨  (*C0 to C7* setting is enabled.)
5. Turn the setting dial until C 4 (C 7) appears. Set to *C4 Terminal 2 speed setting gain*.	 Terminal 2 input is selected  Terminal 4 input is selected
6. Press SET to display the analog voltage (current) value (%).	SET ⇨  Analog voltage (current) value (%) across terminals 2-5 (across terminals 4-5)
7. Apply a 5V (20mA) voltage (current). (Turn the external potentiometer connected across terminals 2-5 (across terminals 4-5) to maximum (any position).)	 * * The value is nearly 100 (%) in the maximum position of the potentiometer.

NOTE

After performing operation in step 6, do not touch the setting dial until completion of calibration.

Operation	Display
8. Press SET to set.	SET ⇨  * Terminal 2 input is selected  Terminal 4 input is elected  **Flicker...Parameter setting complete!!** * The value is nearly 100 (%) in the maximum position of the potentiometer.

- •Turn the setting dial to read another parameter.
- •Press SET to return to the C - - - indication (step 4).
- •Press SET twice to show the next parameter (Pr.CL).

REMARKS

- If the speed meter (display meter) connected across the terminals FM-SD does not indicate exactly 3000r/min, set the *calibration parameter C0 FM terminal calibration*. *(Refer to page 162)*
- If the gain and bias of speed setting voltage (current) are too close, an error (Er3) may be displayed at setting.

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(b) Method to adjust any point without application of a voltage (current) across terminals 2 and 5 (4 and 5)
(To change from 4V (80%) to 5V (100%))

Operation	Display
1. Confirm the operation status indicator and operation mode indicator ● The drive unit should be at a stop. ● The drive unit should be in the PU operation mode. (Use PU/EXT)	0 (MON, PU)
2. Press MODE to choose the parameter setting mode.	MODE ⇨ PRM indicator is lit. P. 1 (PRM) (The parameter number read previously appears.)
3. Turn (dial) until C. . . appears.	(dial) ⇨ C. . .
4. Press SET to display C - - - .	SET ⇨ C - - - (*C0 to C7* setting is enabled.)
5. Turn (dial) until C 4 (C 7) appears. Set to *C4 Terminal 2 speed setting gain*.	(dial) ⇨ C 4: Terminal 2 input is selected; C 7: Terminal 4 input is selected
6. Press SET to display the analog voltage (current) value (%).	SET ⇨ 0.0 Analog voltage (current) value (%) across terminals 2-5 (across terminals 4-5)
7. Turn (dial) to set gain voltage (%). "0V(0mA) is 0%, 10V(5V, 20mA) is 100%"	(dial) ⇨ 100 The gain speed is reached when the analog voltage (current) value across terminals 2-5 (across terminals 4-5) is 100%.

REMARKS

The current setting at the instant of turning (dial) is displayed. You can not check after performing operation in step 7.

80

Operation	Display
8. Press SET to set.	SET ⇨ 100 ⇄ C 4 (Terminal 2 input is selected) / C 7 (Terminal 4 input is selected)

Flicker...Parameter setting complete!!
(Adjustment completed)

- Turn (dial) to read another parameter.
- Press SET to return to the C - - - indication (step 4).
- Press SET twice to show the next parameter (Pr.CL).

REMARKS

By pressing (dial) after step 6, you can confirm the current speed setting bias/gain setting.
You can not check after performing operation in step 7.

(c) Adjusting only the speed without adjusting the gain voltage (current).
(When changing the gain speed from 3000r/min to 1500r/min)

Operation	Display
1. Turn (setting dial) until P. 125 *(Pr.125)* or P. 126 *(Pr.126)* appears	P. 125 (Terminal 2 input is selected) or P. 126 (Terminal 4 input is selected)
2. Press (SET) to show the currently set value. (3000r/min)	SET ⇨ 3000
3. Turn (setting dial) to change the set value to " 1500 ". (1500r/min)	⇨ 1500
4. Press (SET) to set.	SET ⇨ 1500 ⇄ P. 125 (Terminal 2 input is selected) / P. 126 (Terminal 4 input is selected) **Flicker...Parameter setting complete!!**
5. Mode/monitor check Press (MODE) twice to choose the monitor/speed monitor.	MODE ⇨ 0 (MON, PU)
6. Apply a voltage across the drive unit terminals 2-5 (across 4-5) and turn on the start command (STF, STR). Operation starts at 1500r/min.	

REMARKS

- Changing *C4 (Pr.903) or C7 (Pr.905)* (gain adjustment) value will not change the *Pr.20* value.
- For operation from the parameter unit (FR-PU07), refer to the instruction manual of the FR-PU07.
- Make the bias speed setting using the *calibration parameter C2 (Pr.902) or C5 (Pr.904)*. *(Refer to page 174)*

⚠ CAUTION

⚠ **Be cautious when setting any value other than "0" as the bias speed at 0V (0mA). Even if a speed command is not given, merely turning on the start signal will start the motor at the preset speed.**

NOTE

- **Under position control, the bias and gain settings for the speed setting voltage (current) are invalid.**

Parameters referred to

Pr.20 Acceleration/deceleration reference speed ☞ *Refer to page 125*
Pr.73 Analog input selection, Pr.267 Terminal 4 input selection ☞ *Refer to page 168*
Pr.79 Operation mode selection ☞ *Refer to page 186*

4
PARAMETERS

4.16 Misoperation prevention and parameter setting restriction

Purpose	Parameter to set		Refer to page
To limit reset function To trip when PU is disconnected To stop from PU	Reset selection/ disconnected PU detection/PU stop selection	Pr.75	178
To prevent parameter rewrite	Parameter write disable selection	Pr.77	181
To prevent reverse rotation of the motor	Reverse rotation prevention selection	Pr.78	182
To display necessary parameters	Display of applied parameters	Pr.160	182
To restrict parameter using password	Password function	Pr.296, Pr.297	183
To control parameter write by communication	EEPROM write selection	Pr.342	208

4.16.1 Reset selection/disconnected PU detection/PU stop selection (Pr.75)

You can select the reset input acceptance, disconnected PU (FR-PU07) connector detection function and PU stop function.

Parameter number	Name	Initial value	Setting range	Description
75	**Reset selection/ disconnected PU detection/ PU stop selection**	14	0 to 3, 14 to 17	For the initial value, reset always enabled,without disconnected PU detection, and with PU stop function are set.

•The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

•The *Pr.75* value can be set any time. Also, if parameter (all) clear is executed, this setting will not return to the initial value.

Pr.75 Setting	Reset Selection	Disconnected PU Detection	PU Stop Selection
0	Reset input normally enabled	If the PU is disconnected, operation will be continued.	Pressing STOP RESET decelerates the motor to a stop only in the PU operation mode.
1	Reset input is enabled only when the fault occurs.		
2	Reset input normally enabled	When the PU is disconnected, the drive unit trips.	
3	Reset input is enabled only when the fault occurs.		
14 (initial value)	Reset input normally enabled	If the PU is disconnected, operation will be continued.	Pressing STOP RESET decelerates the motor to a stop in any of the PU, External and Network operation modes.
15	Reset input is enabled only when the fault occurs.		
16	Reset input normally enabled	When the PU is disconnected, the drive unit trips.	
17	Reset input is enabled only when the fault occurs.		

(1) Reset selection

- You can select the enable condition of reset function (RES signal, reset command through communication) input.
- When *Pr.75* is set to any of "1, 3, 15, 17", a reset can be input only when the drive unit is tripped.

NOTE

- **When the reset signal (RES) is input during operation, the motor coasts since the drive unit being reset shuts off the output.**
- **When reset is performed, cumulative values of electronic thermal O/L relay, regenerative brake duty are cleared.**
- **The reset key of the PU is only valid when the drive unit is tripped, independently of the *Pr.75* setting.**

(2) Disconnected PU detection

- This function detects that the PU (FR-PU07) has been disconnected from the drive unit for longer than 1s and causes the drive unit to provide a fault output (E.PUE) and come to trip.
- When *Pr.75* is set to any of "0, 1, 14, 15", operation is continued if the PU is disconnected.

REMARKS

- When the PU has been disconnected since before power-ON, it is not judged as a fault.
- To make a restart, confirm that the PU is connected and then reset the drive unit.
- The motor decelerates to a stop when the PU is disconnected during PU Jog operation with *Pr.75* set to any of "0, 1, 14, 15" (which selects operation is continued if the PU is disconnected).
- When RS-485 communication operation is performed through the PU connector, the reset selection/PU stop selection function is valid but the disconnected PU detection function is invalid.

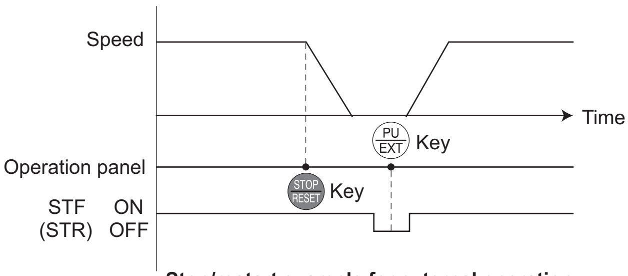
(3) PU stop selection

- In any of the PU operation, External operation and Network operation modes, the motor can be stopped by pressing STOP key of the operation panel or parameter unit (FR-PU07).
- When the drive unit is stopped by the PU stop function, " PS " (PS) is displayed. A fault output is not provided.
- After the motor is stopped from the PU, it is necessary to perform PU stop (PS) reset to restart. PS reset can be made from the unit from which PU stop is made (operation panel, parameter unit (FR-PU07).
- The motor can be restarted by making PS cancel using a power supply reset or RES signal.
- When *Pr.75* is set to any of "0 to 3", PU stop (PS display) is invalid, deceleration to a stop by STOP/RESET is valid only in the PU operation mode.

REMARKS

During operation in the PU operation mode through RS-485 communication from the PU connector, the motor decelerates to stop (PU stop) when entered from the operation panel STOP/RESET.

(4) How to restart the motor stopped by STOP/RESET input from the PU in External operation mode (PU stop (PS) reset method)



Stop/restart example for external operation

a) Operation panel

1)After completion of deceleration to a stop, switch OFF the STF or STR signal.

2)Press PU/EXT to display PU . ...(PS reset)

3)Press PU/EXT to return to EXT .

4)Switch ON the STF or STR signal.

b)Parameter unit (FR-PU07)

1)After completion of deceleration to a stop, switch OFF the STF or STR signal.

2)Press EXT . ...(PS reset)

3)Switch ON the STF or STR signal.

- The motor can be restarted by making a reset using a power supply reset or RES signal.

REMARKS

- If *Pr.250 Stop selection* is set to other than "9999" to select coasting to a stop, the motor will not be coasted to a stop but decelerated to a stop by the PU stop function during external operation.

(5) Restart (PS reset) method when PU stop (PS display) is made during PU operation

- PU stop (PS display) is made when the motor is stopped from the unit where control command source is not selected (operation panel, parameter unit (FR-PU07) in the PU operation mode.
  For example, when *Pr.551 PU mode operation command source selection* = "9999" (initial value), the motor is stopped from the PU (PS display) if entered from the operation panel STOP/RESET in PU operation mode with the parameter unit mounted.

When the motor is stopped from the PU when the parameter unit (FR-PU07) is selected as control command source.

1) After the motor has decelerated to a stop, press STOP/RESET of the parameter unit (FR-PU07).

2) Press PU/EXT to display EXT. (PS reset)

3) Press PU of the parameter unit (FR-PU07) to select the PU operation mode.

4) Press FWD or REV of the parameter unit (FR-PU07).

REMARKS

- When *Pr.551* = "9999", the priorities of the PU command source is USB connector > parameter unit (FR-PU07) > operation panel.

⚠ CAUTION

⚠ **Do not reset the drive unit while the start signal is being input.**
Otherwise, the motor will start instantly after resetting, leading to potentially hazardous conditions.

Parameters referred to

Pr.250 Stop selection *Refer to page 137*
Pr.551 PU mode operation command source selection *Refer to page 195*

4.16.2 Parameter write disable selection (Pr.77)

You can select whether write to various parameters can be performed or not. Use this function to prevent parameter values from being rewritten by misoperation.

Parameter number	Name	Initial value	Setting range	Description
77	**Parameter write selection**	0	0	Write is enabled only during a stop.
			1	Parameter can not be written.
			2	Parameter write is enabled in any operation mode regardless of operation status.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
Pr.77 can always be set independently from the operation mode and operation status.

(1) Write parameters only during stop *(setting "0" initial value)*

- Parameters can be written only during a stop in the PU operation mode.
- The shaded parameters in the parameter list *(page 52)* can always be written regardless of the operation mode and operating status.

(2) Inhibit parameter write *(setting "1")*

- Parameter write is not enabled. (Read is enabled.)
- Parameter clear and all parameter clear cannot be performed, either.
- The parameters given on the right can be written if *Pr.77* = "1".

Parameter number	Name
22	Torque limit level
75	Reset selection/disconnected PU detection/ PU stop selection
77	Parameter write selection
79	Operation mode selection
160	Extended function display selection
296	Password lock level
297	Password lock/unlock
997	Fault initiation

(3) Write parameters during operation *(setting "2")*

- Parameters can always be written.
- The following parameters cannot be written when the drive unit is running if *Pr.77* = "2". Stop the drive unit when changing their parameter settings.

Parameter number	Name
40	RUN key rotation direction selection
48	Second torque limit level
79	Operation mode selection
178 to 184	(Input terminal function selection)
190 to 192	(Output terminal function selection)
420	Command pulse multiplication numerator (electronic gear numerator)
421	Command pulse multiplication denominator (electronic gear denominator)
463	Position control rotation direction selection

Parameter number	Name
535	Position control terminal input selection
537	Roll feed mode selection
658	Wiring resistance
736	Electromagnetic brake interlock time
785	PM control torque boost
795	DC brake torque boost
800	Control method selection
998	PM parameter initialization
999	Automatic parameter setting

Parameters referred to

Pr.79 Operation mode selection *Refer to page 186*

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4.16.3 Reverse rotation prevention selection (Pr.78)

This function can prevent reverse rotation fault resulting from the incorrect input of the start signal.

Parameter number	Name	Initial value	Setting range	Description
78	**Reverse rotation prevention selection**	0	0	Both forward and reverse rotations allowed
			1	Reverse rotation disabled
			2	Forward rotation disabled

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

- Set this parameter when you want to limit the motor rotation to only one direction.
- This parameter is valid for all of the reverse rotation and forward rotation keys of the operation panel and parameter unit (FR-PU07), the start signals (STF, STR signals) via external terminals, and the forward and reverse rotation commands through communication.

4.16.4 Extended parameter display (Pr.160)

Parameter which can be read from the operation panel and parameter unit can be restricted.

Parameter number	Name	Initial value	Setting range	Description
160 *	**Extended function display selection**	0	9999	Displays only the simple mode parameters
			0	Displays simple mode + extended parameters

* This parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

(1) Display of simple mode parameters and extended parameters *(Pr.160)*

- When *Pr.160* = "9999", only the simple mode parameters can be displayed on the operation panel and parameter unit (FR-PU07). (Refer to the parameter list, *page 52*, for the simple mode parameters.)
- In the initial setting (*Pr.160* = "0") status, simple mode parameters and extended parameters can be displayed.

REMARKS

- When communication is used to read the parameters, all parameters can be read, regardless of the *Pr.160* setting.
- When RS-485 communication is used to read the parameters, all parameters can be read, regardless of the *Pr.550 NET mode operation command source selection*, *Pr.551 PU mode operation command source selection*, regardless of *Pr.160* setting.

<table>
<tr><th>Pr.551</th><th>Pr.550</th><th>Pr.160 Valid/Invalid</th></tr>
<tr><td>2(PU)</td><td>-</td><td>Valid</td></tr>
<tr><td rowspan="4">3 (USB)
9999
(auto detect initial value)</td><td>0 (OP)</td><td>Valid</td></tr>
<tr><td>2 (PU)</td><td>Invalid (all parameters can be read)</td></tr>
<tr><td rowspan="2">9999
(auto detect initial value)</td><td>With OP: valid</td></tr>
<tr><td>Without OP: invalid (all parameters can be read)</td></tr>
</table>

* OP indicates a communication option.

- *Pr.15 Jog speed setting*, *Pr.16 Jog acceleration/deceleration time*, and *Pr.991 PU contrast adjustment* are displayed as simple mode parameter when the parameter unit (FR-PU07) is fitted.

4.16.5 Password function (Pr.296, Pr.297)

Registering 4-digit password can restrict parameter reading/writing.

Parameter number	Name	Initial value	Setting range	Description
296 *1	**Password lock level**	9999	0 to 6, 100 to 106	Select restriction level of parameter reading/ writing when a password is registered.
			9999	No password lock
297 *2	**Password lock/unlock**	9999	1000 to 9998	Register a 4-digit password
			(0 to 5) *3	Displays password unlock error count. (Reading only) (Valid when *Pr.296* = "100" to "106")
			9999 *3	No password lock

*1 This parameter can be set when *Pr.160 Extended function display selection* = "0."
*2 If *Pr.296* = "9999" (no password lock), *Pr.297* can be set while *Pr.160* = "0." When the password lock is valid, *Pr.297* can be set regardless of the *Pr.160* setting.
*3 *Pr.297* can be written as "0 or 9999," but the *Pr.297* setting does not change.

(1) Parameter reading/writing restriction level *(Pr.296)*

- Level of reading/writing restriction by PU/NET mode operation command can be selected by *Pr.296*.

Pr.296 Setting	PU Mode Operation Command *3		NET Mode Operation Command *4			
			RS-485 communication		Communication option	
	Read *1	Write *2	Read	Write *2	Read	Write *2
9999	○	○	○	○	○	○
0, 100 *5	×	×	×	×	×	×
1, 101	○	×	○	×	○	×
2, 102	○	×	○	○	○	○
3, 103	○	○	○	×	○	×
4, 104	×	×	×	×	○	×
5, 105	×	×	○	○	○	○
6, 106	○	○	×	×	○	×

○: enabled, ×: restricted

*1 If the parameter reading is restricted by the *Pr.160* setting, those parameters are unavailable for reading even when "○" is indicated.
*2 If the parameter writing is restricted by the *Pr.77* setting, those parameters are unavailable for writing even when "○" is indicated.
*3 Parameter access from unit where parameter is written in PU operation mode (initially set to operation panel, parameter unit) is restricted. (*Refer to page 195* for PU mode operation command source selection)
*4 This restricts parameter access from the command source that can write a parameter under Network operation mode (initially RS-485 communication from PU connector or a communication option). (*Refer to page 195* for NET mode command source.)
*5 If a communication option is installed, option fault (E.OPT) occurs, and drive unit trips. *(Refer to page 275.)*

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(2) Password lock/unlock *(Pr.296, Pr.297)*

<Lock>

1) Set parameter reading/writing restriction level. (*Pr.296* ≠ 9999)

Pr.296 Setting Value	Restriction of Password Unlock Error	*Pr.297* Display
0 to 6	No restriction	Always 0
100 to 106	Restricted at fifth error	Displays error count (0 to 5)

* During [*Pr.296* = any of "100 to 106"], if password unlock error has occurred 5 times, correct password will not unlock the restriction. All parameter clear can unlock the restriction. (In this case, parameter settings are cleared.)

2) Write a four-digit number (1000 to 9998) in *Pr.297* as a password.
(When *Pr.296* = "9999", *Pr.297* cannot be written.)
When password is registered, parameter reading/writing is restricted with the restriction level set in *Pr.296* until unlocking.

REMARKS

- After registering a password, a read value of *Pr.297* is always one of "0" to "5".
- When a password restricted parameter is read/written, LOCd is displayed.
- Even if a password is registered, parameters which the drive unit itself writes, such as drive unit parts life, are overwritten as needed.
- Even if a password is registered, *Pr.991 PU contrast adjustment* can be read/written when a parameter unit (FR-PU07) is connected.

<Unlock>

There are two ways of unlocking the password.

- Enter a password in *Pr.297*.
  Unlocked when a password is correct. If a password is incorrect, an error occurs and not unlocked.
  During [*Pr.296* = any of "100 to 106"], if password unlock error has occurred 5 times, correct password will not unlock the restriction. (During password lock)
- Perform all parameter clear.

NOTE

- **If the password has been forgotten, perform all parameter clear to unlock the parameter restriction. In that case, other parameters are also cleared.**
- **Parameter all clear can not be performed during the operation.**

REMARKS

- The password unlock method is different for operation panel/FR-PU07, RS-485 communication, and communication option.

	Operation panel/ FR-PU07	RS-485 communication	Communication option
All parameter clear	○	○	○
Parameter clear	×	×	○

○: Password can be unlocked., ×: Password cannot be unlocked.

- For parameter clear and all parameter clear from the communication option or the parameter unit (FR-PU07), refer to the instruction manual of each options. (*Refer to page 261* for the operation panel, *refer to page 209* for the Mitsubishi inverter protocol with RS-485 terminal communication, and *refer to page 222* for Modbus-RTU communication protocol.)

(3) Parameter operation during password lock/unlock

Parameter operation		Unlocked		Password registered	Locked
		Pr.296 = 9999 *Pr.297* = 9999	*Pr.296* ≠ 9999 *Pr.297* = 9999	*Pr.296* ≠ 9999 *Pr.297* = 0 to 4 (Read value)	*Pr.296* = 100 to 106 *Pr.297* = 5 (Read value)
Pr.296	Read	○ *1	○	○	○
	Write	○ *1	○ *1	×	×
Pr.297	Read	○ *1	○	○	○
	Write	×	○	○	○ *3
Performing parameter clear		○	○	× *4	× *4
Performing parameter all clear		○	○	○ *2	○ *2
Performing parameter copy		○	○	×	×

○: enabled, ×: restricted

*1 Reading/writing is unavailable when there is restriction to reading by the *Pr.160* setting. (Reading is available in NET mode regardless of *Pr.160* setting.)
*2 Unavailable during the operation.
*3 Correct password will not unlock the restriction.
*4 Parameter clear is available only from the communication parameter.

REMARKS

- When *Pr.296* = any of "4, 5, 104, 105" (password lock), the setting screen for PU JOG speed is not displayed in the parameter unit (FR-PU07).
- During password lock, parameter copy of the parameter unit (FR-PU07) cannot be performed.

Parameters referred to

Pr.77 Parameter write selection ☞ *Refer to page 181*
Pr.160 Extended function display selection ☞ *Refer to page 182*
Pr.550 NET mode operation command source selection ☞ *Refer to page 195*
Pr.551 PU mode operation command source selection ☞ *Refer to page 195*

4.17 Selection of operation mode and operation location

<table>
<tr><th>Purpose</th><th colspan="2">Parameter to set</th><th>Refer to page</th></tr>
<tr><td>To select operation mode</td><td>Operation mode selection</td><td>Pr.79</td><td>186</td></tr>
<tr><td>To start up in Network operation mode</td><td>Operation mode at power-ON</td><td>Pr.79, Pr.340</td><td>194</td></tr>
<tr><td>To select operation location</td><td>Operation command source and speed command source during communication operation, selection of operation location</td><td>Pr.338, Pr.339, Pr.550, Pr.551</td><td>195</td></tr>
</table>

4.17.1 Operation mode selection (Pr.79)

Used to select the operation mode of the drive unit.
Mode can be changed as desired among operation using external command signals (External operation mode), operation from the operation panel and PU (FR-PU07) (PU operation), combined operation of PU operation and External operation mode (External/PU combined operation), and Network operation (when RS-485 communication or a communication option is used).

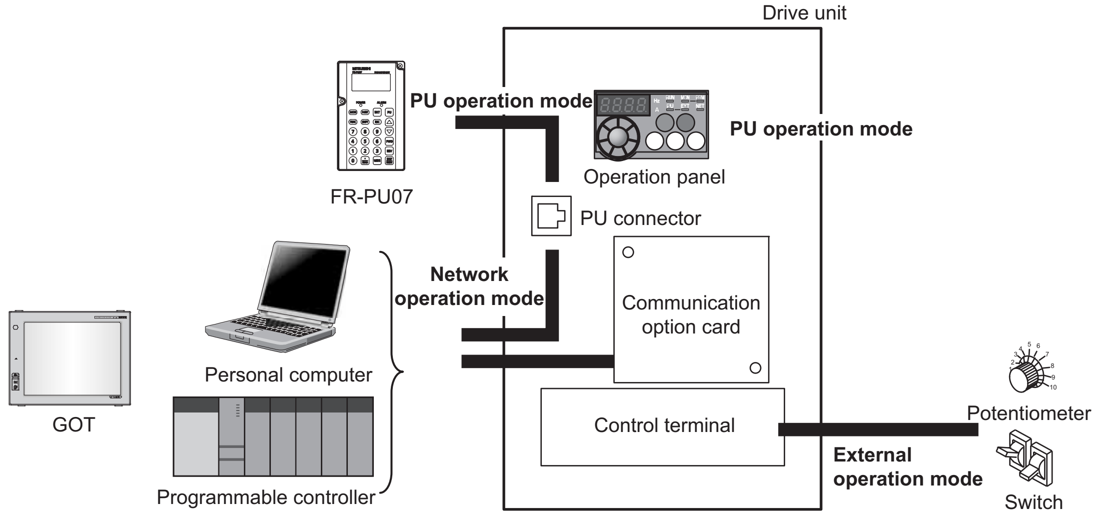
<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th>Description</th><th>LED Indicator
: OFF
: ON</th></tr>
<tr><td rowspan="6">79</td><td rowspan="6">Operation mode selection</td><td rowspan="6">0</td><td>0</td><td>Use External/PU switchover mode (PU/EXT) to switch between the PU and External operation mode.
At power on, the drive unit is in the External operation mode mode.</td><td>PU operation mode
PU
External operation mode
EXT
NET operation mode
NET</td></tr>
<tr><td>1</td><td>Fixed to PU operation mode</td><td>PU operation mode
PU</td></tr>
<tr><td>2</td><td>Fixed to External operation mode
Operation can be performed by switching between the External and NET operation mode.</td><td>External operation mode
EXT
NET operation mode
NET</td></tr>
<tr><td>3</td><td>External/PU combined operation mode 1<table><tr><th>Speed command</th><th>Start command</th></tr><tr><td>Operation panel and PU (FR-PU07) setting or external signal input (multi-speed setting, across terminals 4-5 (valid when AU signal turns ON)).*</td><td>External signal input (terminal STF, STR)</td></tr></table></td><td rowspan="2">External/PU combined operation mode
PU EXT</td></tr>
<tr><td>4</td><td>External/PU combined operation mode 2<table><tr><th>Speed command</th><th>Start command</th></tr><tr><td>External signal input (terminal 2, 4, JOG, multi-speed selection, etc.)</td><td>Enter from RUN of the operation panel and FWD and REV of the PU (FR-PU07)</td></tr></table></td></tr>
<tr><td>6</td><td>Switchover mode
Switchover between PU operation, External operation, and NET operation is available while keeping the same operation status.</td><td rowspan="2">PU operation mode
PU
External operation mode
EXT
NET operation mode
NET</td></tr>
<tr><td></td><td></td><td></td><td>7</td><td>External operation mode (PU operation interlock)
X12 signal ON
Operation mode can be switched to the PU operation mode. (output stop during external operation)
X12 signal OFF
Operation mode can not be switched to the PU operation mode.</td></tr>
</table>

The above parameters can be changed during a stop in any operation mode.

* The priorities of the speed commands when Pr.79 = "3" are "Multi-speed operation (RL/RM/RH/REX) > PID control (X14) > terminal 4 analog input (AU) > digital input from the operation panel".

(1) Operation mode basics

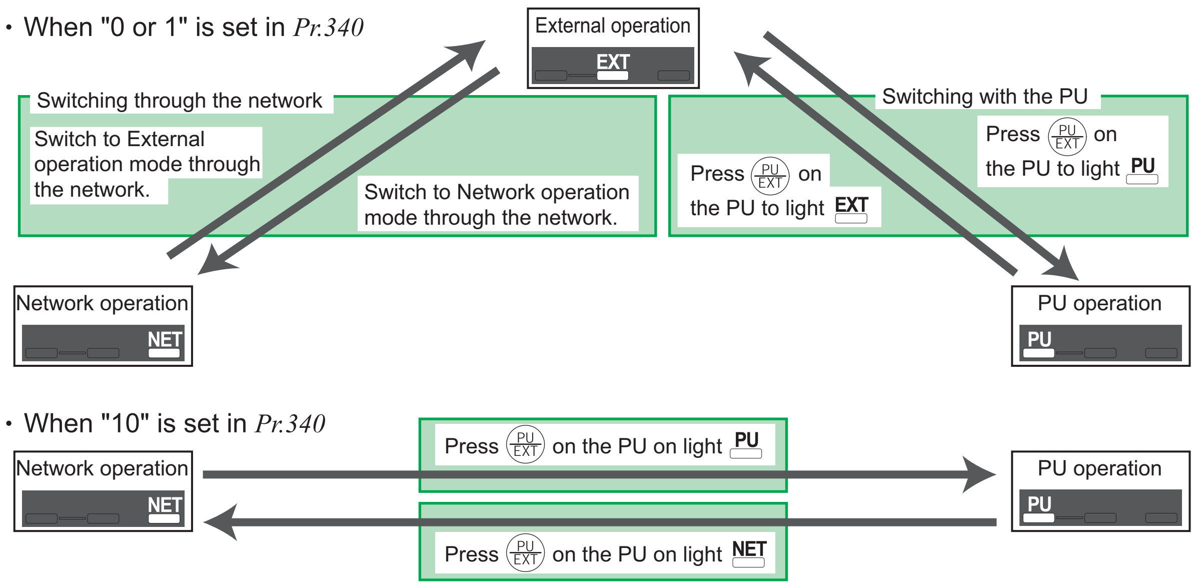
- The operation mode specifies the source of the start command and the speed command for the drive unit.
- Basically, there are following operation modes.
  - External operation mode: For inputting start command and speed command with an external potentiometer and switches which are connected to the control circuit terminal.
  - PU operation mode: For inputting start command and speed command with the operation panel or parameter unit (FR-PU07).
  - Network operation mode (NET operation mode): For inputting start command and speed command with RS-485 communication through PU connector or communication option.
- The operation mode can be selected from the operation panel or with the communication instruction code.



REMARKS

- The PU operation mode is not available under position control.
- Either "3" or "4" may be set to select the PU/External combined mode.
- The stop function (PU stop selection) activated by pressing STOP/RESET of the operation panel and parameter unit (FR-PU07) is valid even in other than the PU operation mode in the initial setting.
  (Pr.75 Reset selection/disconnected PU detection/PU stop selection Refer to page 178)

(2) Operation mode switching method



REMARKS

- Refer to the following for switching by the external terminal.
  PU operation external interlock signal (X12) Refer to page 191
  PU-external operation switch-over signal (X16) Refer to page 192
  External-NET operation switchover signal (X65), NET-PU operation switchover signal (X66) Refer to page 192
  Pr.340 Communication startup mode selection Refer to page 194

4

PARAMETERS

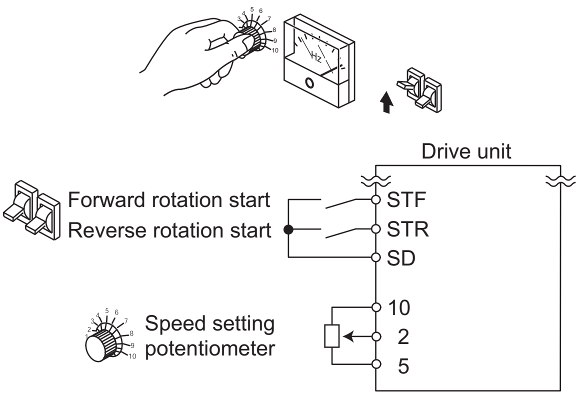
(3) Operation mode selection flow

In the following flowchart, select the basic parameter setting and terminal connection related to the operation mode.

START

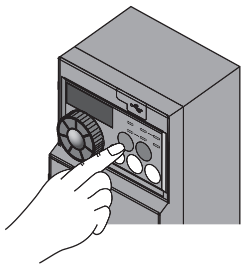
Where is the start command source?	Where is the speed command source?	Connection	Parameter setting	Operation
From outside (STF/STR terminal)	From outside (Terminal 2, 4, JOG, multi-speed, etc.)	STF (forward rotation)/ STR (reverse rotation) *(Refer to page 138.)* Terminal 2, 4-5 (analog), RL, RM, RH, JOG, etc.		Speed setting terminal ON STF(STR)-ON
From outside (STF/STR terminal)	From PU (digital setting)	STF (forward rotation)/ STR (reverse rotation) *(Refer to page 138)*	*Pr.79* = "3" (External/PU combined operation mode1)	Operation panel, PU digital setting STF(STR)-ON
From outside (STF/STR terminal)	From communication (PU connector communication option) — PU connector or communication option? PU connector (RS-485 communication)	STF (forward rotation)/ STR (reverse rotation) (*Refer to page 138*)	*Pr.338* = "1" *Pr.340* = "1"	Communication speed setting command sending STF(STR)-ON
From outside (STF/STR terminal)	From communication (PU connector communication option) — PU connector or communication option? Communication option	Connection of communication option (Refer to the corresponding communication option instruction manual)	*Pr.338* = "1" *Pr.340* = "1"	Communication speed setting command sending STF(STR)-ON
From the operation panel (RUN/FWD/REV key)	From outside (terminal 2, 4, JOG, multi-speed, etc.)	Terminal 2, 4-5 (analog), RL, RM, RH, JOG, etc..	*Pr.79* = "4" (External/PU combined operation 2)	Speed setting terminal ON RUN/FWD/REV key ON
From the operation panel (RUN/FWD/REV key)	From the operation panel (digital setting)		*Pr.79* = "1" (fixed to PU operation)	Digital setting RUN/FWD/REV key ON
From the operation panel (RUN/FWD/REV key)	From communication (PU connector/communication option)	✕ **Disabled**		
From communication (PU connector/communication option) — PU connector or communication option? PU connector (RS-485 communication)	From outside (terminal 2, 4, JOG, multi-speed, etc.)	Terminal 2, 4-5 (analog), RL, RM, RH, JOG, etc.	*Pr.339* = "1" *Pr.340* = "1"	Speed setting terminal ON Communication start command sending
From communication (PU connector/communication option) — PU connector or communication option? PU connector (RS-485 communication)	From the operation panel (digital setting)		✕ **Disabled**	
From communication (PU connector/communication option) — PU connector or communication option? PU connector (RS-485 communication)	From communication (PU connector)		*Pr.340* = "1"	Communication speed setting command sending Communication start command sending
From communication (PU connector/communication option) — PU connector or communication option? Communication option	From outside (terminal 2, 4, JOG, multi-speed, etc.)	Connection of communication option (Refer to the corresponding communication option instruction manual) Terminal 2, 4-5 (analog), RL, RM, RH, JOG, etc.	*Pr.339* = "1" *Pr.340* = "1"	Speed setting terminal ON Communication start command sending
From communication (PU connector/communication option) — PU connector or communication option? Communication option	From the operation panel (digital setting)		✕ **Disabled**	
From communication (PU connector/communication option) — PU connector or communication option? Communication option	From communication (communication option)	Connection of communication option (Refer to the corresponding communication option instruction manual)	*Pr.340* = "1"	Communication speed setting command sending Communication start command sending

(4) External operation mode *(setting "0" (initial value), "2")*

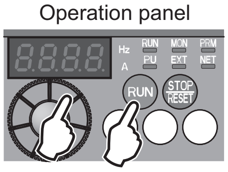


- Select the External operation mode when the start command and the speed command are applied from a speed setting potentiometer, start switch, etc. which are provided externally and connecting them to the control circuit terminals of the drive unit.
- Generally, parameter change cannot be performed in the External operation mode.
  (Some parameters can be changed. Refer to the detailed description of each parameter.)
- When "0" or "2" is selected for *Pr.79*, the drive unit enters the External operation mode at power-ON. (When using the Network operation mode, refer to *page 194*.)
- When parameter changing is seldom necessary, setting "2" fixes the operation mode to the External operation mode.
  When frequent parameter changing is necessary, setting "0" (initial value) allows the operation mode to be changed easily to the PU operation mode by pressing PU/EXT of the operation panel. When you switched to the PU operation mode, always return to the External operation mode.
- The STF and STR signal are used as a start command, and the voltage or current signal to terminal 2, 4, multi-speed signal, JOG signal, etc. are used as a speed command.

(5) PU operation mode *(setting "1")*

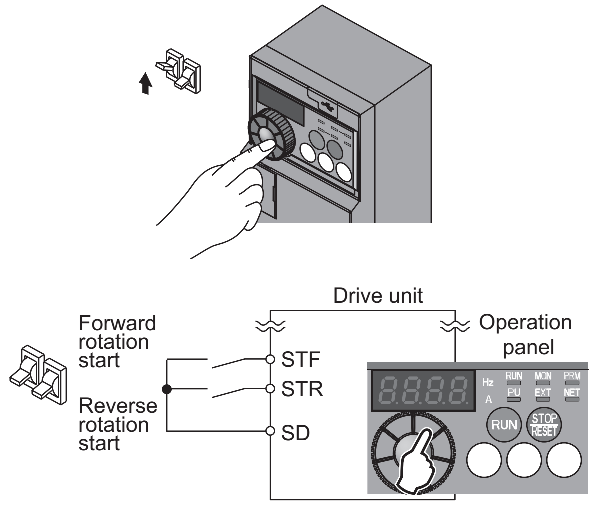


Operation panel



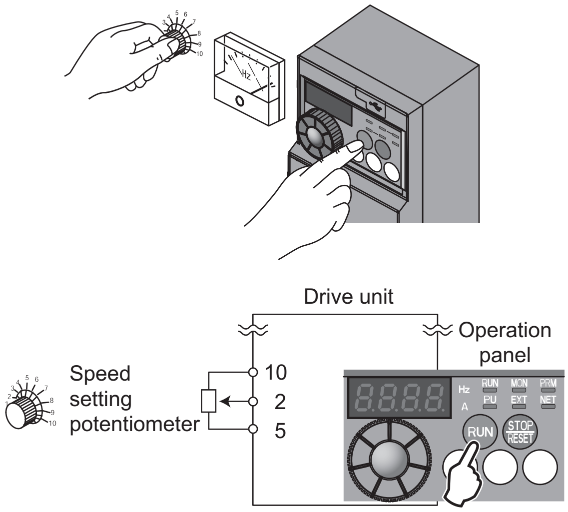
- Select the PU operation mode when applying start and speed command by only the key operation of the operation panel (FR-PU07). Also select the PU operation mode when making communication using the PU connector.
- When "1" is selected for *Pr.79*, the drive unit enters the PU operation mode at power ON. You cannot change to the other operation mode.
- The setting dial of the operation panel can be used for setting like a potentiometer. *(Pr.161 Speed setting/key lock operation selection (Refer to page 256))*

(6) PU/External combined operation mode 1 *(setting "3")*



- Select the PU/External combined operation mode 1 when applying speed command from the operation panel or parameter unit (FR-PU07) and inputting the start command with the external start switch.
- Select "3" for *Pr.79*. You cannot change to the other operation mode.
- When a speed is applied from the external signal by multi-speed setting, it has a higher priority than the speed command from the PU. When AU is ON, the command signal to terminal 4 is used.

(7) PU/External combined operation mode 2 *(setting "4")*



- Select the PU/External combined operation mode 2 when applying speed command from the external potentiometer, multi-speed or JOG signal and inputting the start command by key operation of the operation panel or parameter unit (FR-PU07).
- Select "4" for *Pr.79*. You cannot change to the other operation mode.

(8) Switch-over mode *(setting "6")*

- While continuing operation, you can switch between the PU operation, external operation and network operation (when RS-485 communication with the PU connector or communication option is used).

Operation Mode Switching	Switching Operation/Operating Status
External operation → PU operation	Select the PU operation mode with the operation panel or parameter unit. • Rotation direction is the same as that of External operation. • The speed set with the potentiometer (speed command) or like is used unchanged. (Note that the setting will disappear when power is switched OFF or the drive unit is reset.)
External operation → NET operation	Send the mode change command to the Network operation mode through communication. • Rotation direction is the same as that of External operation. • The value set with the setting potentiometer (speed command) or like is used unchanged. (Note that the setting will disappear when power is switched OFF or the drive unit is reset.)
PU operation → External operation	Press the external operation key of the operation panel or parameter unit. • The rotation direction is determined by the input signal of the External operation. • The set speed is determined by the external speed command signal.
PU operation → NET operation	Send the mode change command to the Network operation mode through communication. • Rotation direction and set speed are the same as those of PU operation.
NET operation → External operation	Command to change to External mode is transmitted by communication. • Rotation direction is determined by the external operation input signal. • The set speed is determined by the external speed command signal.
NET operation → PU operation	Select the PU operation mode with the operation panel or parameter unit. • The rotation direction and speed command in the Network operation mode are used unchanged.

(9) PU operation interlock *(setting "7")*

- The PU operation interlock function is designed to forcibly change the operation mode to the External operation mode when the PU operation interlock signal (X12) input turns OFF.
  This function prevents the drive unit from being inoperative by the external command if the mode is accidentally left unswitched from PU operation mode.
- Set "7" (PU operation interlock) in *Pr.79*.
- For the terminal used for X12 signal (PU operation interlock signal) input, set "12" to any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function. (Refer to *page 138* for *Pr.178 to Pr.184*.)
- When the X12 signal is not assigned, function of the MRS signal switches from MRS (output stop) to PU operation interlock signal.

X12 (MRS) Signal	Function/Operation	
	Operation Mode	**Parameter Write**
ON	Operation mode (External, PU, NET) switching enabled Output stop during External operation	Parameter write enabled (depending on *Pr.77 Parameter write selection* and each parameter write conditions (*Refer to page 52* for the parameter list))
OFF	Forcibly switched to External operation mode External operation allowed Switching between the PU and NET operation mode is enabled	Parameter write disabled with exception of *Pr.79*

<Function/operation changed by switching ON-OFF the X12 (MRS) signal>

Operating Condition		X12 (MRS) Signal	Operation Mode	Operating Status	Switching to PU, NET Operation Mode
Operation Mode	**Status**				
PU/NET	During stop	ON → OFF ∗1	External ∗2	If external operation speed setting and start signal are entered, operation is performed in that status.	Disallowed
	Running	ON → OFF ∗1			Disallowed
External	During stop	OFF → ON	External ∗2	During stop	Allowed
		ON → OFF			Disallowed
	Running	OFF → ON		During operation → output stop	Disallowed
		ON → OFF		Output stop → operation	Disallowed

∗1 The operation mode switches to the External operation mode independently of whether the start signal (STF, STR) is ON or OFF. Therefore, the motor is run in External operation mode when the X12 (MRS) signal is turned OFF with either of STF and STR ON.

∗2 At fault occurrence, pressing STOP RESET of the operation panel resets the drive unit.

NOTE

- **If the X12 (MRS) signal is ON, the operation mode cannot be switched to the PU operation mode when the start signal (STF, STR) is ON.**
- **When the MRS signal is used as the PU interlock signal, the MRS signal serves as the normal MRS function (output stop) by turning ON the MRS signal and then changing the *Pr.79* value to other than "7" in the PU operation mode. As soon as "7" is set to *Pr.79* , the MRS signal acts as the PU interlock signal.**
- **When the MRS signal is used as the PU interlock signal, the logic of the signal is as set in *Pr.17*. When *Pr.17* = "2", read ON as OFF and OFF as ON in the above explanation.**
- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

(10) Switching of operation mode by external signal (X16 signal)

- When external operation and operation from the operation panel are used together, use of the PU-External operation switching signal (X16) allows switching between the PU operation mode and External operation mode during a stop (during a motor stop, start command OFF).
- When *Pr.79* = any of "0, 6, 7", the operation mode can be switched between the PU operation mode and External operation mode. (*Pr.79* = "6" At Switchover mode, operation mode can be changed during operation)
- For the terminal used for X16 signal input, set "16" to any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the function.

Pr.79 Setting		X16 Signal State Operation Mode		Remarks
		ON (External)	OFF (PU)	
0 (initial value)		External operation mode	PU operation mode	Can be switched to External, PU or NET operation mode
1		PU operation mode		Fixed to PU operation mode
2		External operation mode		Fixed to External operation mode (can be switched to NET operation mode)
3, 4		External/PU combined operation mode		External/PU combined mode fixed
6		External operation mode	PU operation mode	Switching among the External, PU, and NET operation mode is enabled while running.
7	X12 (MRS) ON	External operation mode	PU operation mode	Can be switched to External, PU or NET operation mode (output stop in External operation mode)
	X12 (MRS) OFF	External operation mode		Fixed to External operation mode (forcibly switched to External operation mode)

REMARKS

- The operation mode status changes depending on the setting of *Pr.340 Communication startup mode selection* and the ON/OFF status of the X65 and X66 signals. (For details, *Refer to page 192*)
- The priorities of *Pr.79* , *Pr.340* and signals are *Pr.79* > X12 > X66 > X65 > X16 > *Pr.340*.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

(11) Switching of operation mode by external signals (X65, X66 signals)

- When *Pr.79* = any of "0, 2, 6, 7", the operation mode switching signals (X65, X66) can be used to change the PU or External operation mode to the Network operation mode during a stop (during a motor stop or start command OFF). (*Pr.79* = "6" Switch-over mode can be changed during operation)
- When switching between the Network operation mode and PU operation mode
  1) Set *Pr.79* to "0" (initial value) or "6".
  2) Set "10" in *Pr.340 Communication startup mode selection*.
  3) Set "65" in any of *Pr.178 to Pr.184* to assign the NET-PU operation switching signal (X65) to the terminal.
  4) The operation mode changes to the PU operation mode when the X65 signal turns ON, or to the Network operation mode when the X65 signal turns OFF.

Pr.340 Setting	*Pr.79* Setting		X65 Signal State		Remarks
			ON(PU)	OFF(NET)	
10	0 (initial value)		PU operation mode *1	NET operation mode *2	Cannot be switched to External operation mode
	1		PU operation mode		Fixed to PU operation mode
	2		NET operation mode		Fixed to NET operation mode
	3, 4		External/PU combined operation mode		External/PU combined mode fixed
	6		PU operation mode *1	NET operation mode *2	Operation mode can be switched with operation continued Cannot be switched to External operation mode
	7	X12 (MRS) ON	Switching among the External and PU operation mode is enabled *3		Output stop in External operation mode
		X12 (MRS) OFF	External operation mode		Forcibly switched to External operation mode

*1 NET operation mode when the X66 signal is ON.
*2 PU operation mode is selected when the X16 signal is OFF. PU operation mode also when *Pr.550 NET mode operation command source selection* = "0" (communication option command source) and the communication option is not fitted.
*3 External operation mode when the X16 signal is ON.

- When switching between the Network operation mode and External operation mode
  1) Set *Pr.79* to "0 (initial value), 2, 6 or 7". (At the *Pr.79* setting of "7", the operation mode can be switched when the X12 (MRS) signal turns ON.)
  2) Set "0 (initial value) or 1" in *Pr.340 Communication startup mode selection*.
  3) Set "66" in any of *Pr.178 to Pr.184* to assign the NET-PU operation switching signal (X66) to the terminal.
  4) The operation mode changes to the Network operation mode when the X66 signal turns ON, or to the External operation mode when the X66 signal turns OFF.

Pr.340 Setting	*Pr.79* Setting		X66 Signal State		Remarks
			ON (NET)	OFF (External)	
0 (initial value), 1	0 (initial value)		NET operation mode *1	External operation mode *2	
	1		PU operation mode		Fixed to PU operation mode
	2		NET operation mode *1	External operation mode *2	Cannot be switched to PU operation mode
	3, 4		External/PU combined operation mode		External/PU combined mode fixed
	6		NET operation mode *1	External operation mode *2	Operation mode can be switched with operation continued
	7	X12 (MRS) ON	NET operation mode *1	External operation mode *2	Output stop in External operation mode
		X12 (MRS) OFF	External operation mode		Forcibly switched to External operation mode

*1 PU operation mode is selected when *Pr.550 NET mode operation command source selection* = "0" (communication option command source) and the communication option is not fitted.

*2 PU operation mode is selected when the X16 signal is OFF. When the X65 signal has been assigned, the operation mode changes with the ON/OFF state of the X65 signal.

REMARKS

- The priorities of *Pr.79*, *Pr.340* and signals are *Pr.79* > X12 > X66 > X65 > X16 > *Pr.340*.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.15 Jog speed setting ☞ *Refer to page 119*
Pr.4 to 6, Pr.24 to Pr.27, Pr.232 to Pr.239 Multi-speed operation ☞ *Refer to page 117*
Pr.75 Reset selection/disconnected PU detection/PU stop selection ☞ *Refer to page 178*
Pr.161 Speed setting/key lock operation selection ☞ *Refer to page 256*
Pr.178 to Pr.184 (input terminal function selection) ☞ *Refer to page 138*
Pr.190 to Pr.192 (output terminal function selection) ☞ *Refer to page 144*
Pr.340 Communication startup mode selection ☞ *Refer to page 194*
Pr.550 NET mode operation command source selection ☞ *Refer to page 195*

4.17.2 Operation mode at power-ON (Pr.79, Pr.340)

When power is switched ON or when power comes back on after instantaneous power failure, the drive unit can be started up in the Network operation mode.
After the drive unit has started up in the Network operation mode, parameter write and operation can be performed from a program.
Set this mode for communication operation using PU connector or communication option.

Parameter number	Name	Initial value	Setting range	Description
79	**Operation mode selection**	0	0 to 4, 6, 7	Operation mode selection *(Refer to page 188)*
340 *	**Communication startup mode selection**	0	0	As set in *Pr.79*
			1	Network operation mode
			10	Network operation mode Operation mode can be changed between the PU operation mode and Network operation mode from the operation panel.

The above parameters can be changed during a stop in any operation mode.

* The above parameters can be set when *Pr.160 Extended function display selection* = "0". However, the parameters can be set whenever the communication option is connected. *(Refer to page 182)*

(1) Specify operation mode at power-on *(Pr.340)*

- Depending on the *Pr.79* and *Pr.340* settings, the operation mode at power-on (reset) changes as described below.

Pr.340 Setting	*Pr.79* Setting	Operation Mode at Power-on, Power Restoration, Reset	Operation Mode Switching
0 (initial value)	0 (initial value)	External operation mode	Switching among the External, PU and NET operation mode is enabled *1
	1	PU operation mode	Fixed to PU operation mode
	2	External operation mode	Switching between the External and NET operation mode is enabled Switching to PU operation mode disabled
	3, 4	External/PU combined mode	Operation mode switching disabled
	6	External operation mode	Switching among the External, PU, and NET operation mode is enabled while running.
	7	X12 (MRS) signal ON ....External operation mode	Switching among the External, PU and NET operation mode is enabled *1
		X12 (MRS) signal OFF ..External operation mode	Fixed to External operation mode (Forcibly switched to External operation mode.)
1	0	NET operation mode	Same as when *Pr.340* = "0"
	1	PU operation mode	
	2	NET operation mode	
	3, 4	External/PU combined mode	
	6	NET operation mode	
	7	X12 (MRS) signal ON ....NET operation mode	
		X12 (MRS) signal OFF ..External operation mode	
10	0	NET operation mode	Switching between the PU and NET operation mode is enabled *2
	1	PU operation mode	Same as when *Pr.340* = "0"
	2	NET operation mode	Fixed to NET operation mode
	3, 4	External/PU combined mode	Same as when *Pr.340* = "0"
	6	NET operation mode	Switching between the PU and NET operation mode is enabled while running *2
	7	External operation mode	Same as when *Pr.340* = "0"

*1 Operation mode can not be directly changed between the PU operation mode and Network operation mode

*2 Operation mode can be changed between the PU operation mode and Network operation mode with PU/EXT key of the operation panel and X65 signal.

Parameter referred to

Pr.79 Operation mode selection *Refer to page 186*

4.17.3 Start command source and speed command source during communication operation (Pr.338, Pr.339, Pr.550, Pr.551)

When the RS-485 communication with the PU connector or communication option is used, the external start command and speed command can be valid. Command source in the PU operation mode can be selected.
From the communication device, parameter unit, etc. which have command source, parameter write or start command can be executed. Parameter read or monitoring can be executed in any operation mode.

Parameter number	Name	Initial value	Setting range	Description
338	**Communication operation command source**	0	0	Start command source communication
			1	Start command source external
339	**Communication speed command source**	0	0	Speed command source communication
			1	Speed command source external
			2	Speed command source external (When there is no external input, the speed command via communication is valid, and the speed command from terminal 2 is invalid.)
550 *	**NET mode operation command source selection**	9999	0	The communication option is the command source when NET operation mode.
			2	PU connector is the command source when NET operation mode.
			9999	Automatic communication option recognition Normally, PU connector is the command source. When a communication option is mounted, the communication option is the command source.
551 *	**PU mode operation command source selection**	9999	2	PU connector is the command source when PU operation mode.
			3	USB connector is the command source when PU operation mode.
			4	Operation panel is the command source when PU operation mode.
			9999	USB automatic recognition Normally, operation panel is the command source. When the parameter unit is connected to the PU connector, PU is the command source. When USB is connected, USB connector is the command source.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". However, the parameters can be set whenever the communication option is connected. *(Refer to page 182)*
* This parameter can be changed during a stop in any operation mode.

(1) Select the command source of the Network operation mode *(Pr.550)*

- Either the RS-485 communication with the PU connector or communication option can be specified as the command source in the Network operation mode.
- For example, set *Pr.550* to "2" when executing parameter write, start command or speed command from the unit RS- 485 terminals in the Network operation mode independently of whether the communication option is connected or not.

NOTE

- **Since *Pr.550* = "9999" (automatic communication option recognition) in the initial setting, parameter write, start command and speed command cannot be executed by communication using the unit RS-485 terminals when the communication option is fitted.**

(2) Selects the command source of the PU operation mode (*Pr.551*)

- Any of the operation panel, PU connector can be specified as the command source in the PU operation mode.
- In the PU operation mode, set *Pr.551* to "2" when executing parameter write, start command or speed command during the RS-485 communication with PU communication.

NOTE

- **When performing the RS-485 communication with the PU connector when *Pr.551* = "9999", PU mode command source does not automatically change to the PU connector. Change to the Network operation mode to change the command source.**
- **When "2" (NET mode PU connector) is set in *Pr.550* and "2" (PU mode PU connector) is set in *Pr.551*, PU operation mode has priority. When the communication option is not fitted, therefore, the operation mode cannot be switched to the Network operation mode.**
- **Changed setting value is valid at power-ON or resetting of the drive unit.**
- **The Modbus-RTU protocol cannot be used in the PU operation mode. Select Network operation mode (NET mode command source).**

PU... PU operation mode, NET... network operation mode, —... without command source

Pr.550 Setting	*Pr.551* Setting	Command Source					Remarks
		Operation Panel	USB Connector	PU Connector		Communication Option	
				Parameter Unit	RS-485 Communication		
0	2	—	—	PU	PU *1	NET *2	
	3	—	PU	—	—	NET *2	
	4	PU	—	—	—	NET *2	
	9999 (initial value)	PU *3	PU *3	PU *3	—	NET *2	
2	2	—	—	PU	PU *1	—	Switching to NET operation mode disabled
	3	—	PU	—	NET	—	
	4	PU	—	—	NET	—	
	9999 (initial value)	PU *3	PU *3	PU *3	NET	—	
9999 (initial value)	2	—	—	PU	PU *1	NET *2	
	3	—	PU	—	—	NET *2	Communication option fitted
					NET	—	Communication option not fitted
	4	PU	—	—	—	NET *2	Communication option fitted
					NET		Communication option not fitted
	9999 (initial value)	PU *3	PU *3	PU *3	—	NET *2	Communication option fitted
					NET	—	Communication option not fitted

*1 The Modbus-RTU protocol cannot be used in the PU operation mode. When using the Modbus-RTU protocol, set *Pr.550* to "2".

*2 When the communication option is not fitted, the operation mode cannot be switched to the Network operation mode.

*3 When *Pr.551* = "9999", the priorities of the PU command source is USB connector > parameter unit (FR-PU07) > operation panel.

(3) Controllability through communication

- Controllability through communication in each operation mode is shown below.
- Monitoring and parameter read can be performed from any operation regardless of operation mode.

Operation Location	Condition (*Pr.551* Setting)	Item \ Operation Mode	PU Operation	External Operation	External/PU Combined Operation Mode 1 (*Pr.79* =3)	External/PU Combined Operation Mode 2 (*Pr.79* =4)	NET Operation (When Using PU Connector) ∗6	NET Operation (When Using Communication Option) ∗7
Control by RS-485 communication from PU connector	2 (PU connector)	Run command (start)	O	×	×	O	×	
		Run command (stop)	O	Δ∗3	Δ∗3	O	Δ∗3	
		Running speed setting	O	×	O	×	×	
		Parameter write	O ∗4	× ∗5	O ∗4	O ∗4	× ∗5	
		Drive unit reset	O	O	O	O	O	
	Other than the above	Run command (start)	×	×	×	×	O ∗1	×
		Run command (stop)	×	×	×	×	O ∗1	×
		Running speed setting	×	×	×	×	O ∗1	×
		Parameter write	× ∗5	× ∗5	× ∗5	× ∗5	O ∗4	× ∗5
		Drive unit reset	×	×	×	×	O ∗2	×
Operation from the USB connector	3 (USB connector) 9999 (automatic recognition)	Run command (start, stop)	O	×	×	O	×	
		Running speed setting	O	×	O	×	×	
		Parameter write	O ∗4	× ∗5	× ∗5	× ∗5	× ∗5	
		Drive unit reset	O	O	O	O	O	
	Other than the above	Run command (start, stop)	×	×	×	×	×	
		Running speed setting	×	×	×	×	×	
		Parameter write	× ∗5	× ∗5	× ∗5	× ∗5	× ∗5	
		Drive unit reset	O	O	O	O	O	
Control by communication from communication option	—	Run command (start, stop)	×	×	×	×	×	O ∗1
		Running speed setting	×	×	×	×	×	O ∗1
		Parameter write	× ∗5	× ∗5	× ∗5	× ∗5	× ∗5	O ∗4
		Drive unit reset	×	×	×	×	×	O ∗2
Control circuit external terminals	—	Drive unit reset	O	O	O	O	O	
		Run command (start, stop)	×	O	O	×	× ∗1	
		Speed setting	×	O	Δ ∗8	O	× ∗1	

O: Enabled, ×: Disabled, Δ: Some are enabled

∗1 As set in *Pr.338 Communication operation command source* and *Pr.339 Communication speed command source.* *(Refer to page 195)*

∗2 At occurrence of RS-485 communication error, the drive unit cannot be reset from the computer.

∗3 Enabled only when stopped by the PU. At a PU stop, PS is displayed on the operation panel. As set in *Pr.75 PU stop selection*. *(Refer to page 178)*

∗4 Some parameters may be write-disabled according to the *Pr.77 Parameter write selection* setting and operating status. *(Refer to page 181)*

∗5 Some parameters are write-enabled independently of the operation mode and command source presence/absence. When *Pr.77* = 2, write is enabled. (Refer to the parameter list on *page 52*) Parameter clear is disabled.

∗6 When *Pr.550 NET mode operation command source selection* = "2" (PU connector valid) or *Pr.550 NET mode operation command source selection* = "9999" and the communication option is fitted.

∗7 When *Pr.550 NET mode operation command source selection* = "0" (communication option valid) or *Pr.550 NET mode operation command source selection* = "9999" and the communication option is fitted.

∗8 Available with multi-speed setting and terminal 4-5 (valid when AU signal is ON).

(4) Operation at error occurrence

Error Definition	Operation Mode / Condition (*Pr.551* Setting)	PU Operation	External Operation	External/PU Combined Operation Mode 1 (*Pr.79* = 3)	External/PU Combined Operation Mode 2 (*Pr.79* = 4)	NET Operation (When Used with PU Connector) *5	NET Operation (When Used with Communication Option) *6
Drive unit fault	—	Stop					
PU disconnection of the PU	2 (PU connector) 9999 (automatic recognition)	Stop/continued *1, *4					
	Other than the above	Stop/continued *1					
RS-485 communication error of the PU connector	2 (PU connector)	Stop/continued *2	Continued		Stop/continued	—	Continued
	Other than the above	Continued				Stop/continued *3	Continued
Communication error of USB connector	3 (USB connector) 9999 (automatic recognition)	Stop/continued *2	Continued		Stop/continued *2	Continued	
	Other than the above	Continued					
Communication error of communication option	—	Continued					Stop/continued *3

*1 Can be selected using *Pr.75 Reset selection/disconnected PU detection/PU stop selection*.

*2 Can be selected using *Pr.122 PU communication check time interval*, *Pr.336 RS-485 communication check time interval*, *Pr.548 USB communication check time interval*.

*3 As controlled by the communication option.

*4 In the PU JOG operation mode, operation is always stopped when the PU is disconnected. Whether fault (E.PUE) occurrence is allowed or not is as set in *Pr.75 Reset selection/disconnected PU detection/PU stop selection*.

*5 When *Pr.550 NET mode operation command source selection* = "2" (PU connector valid) or *Pr.550 NET mode operation command source selection* = "9999" and the communication option is fitted.

*6 When *Pr.550 NET mode operation command source selection* = "0" (communication option valid) or *Pr.550 NET mode operation command source selection* = "9999" and the communication option is fitted.

(5) Selection of command source in Network operation mode *(Pr.338, Pr.339)*

- There are two control sources: operation command source, which controls the signals related to the drive unit start command and function selection, and speed command source, which controls signals related to speed setting.
- In Network operation mode, the commands from the external terminals and communication (PU connector or communication option) are as listed below.

<table>
<tr><th colspan="3" rowspan="2">Operation Location Selection</th><th colspan="2">Pr.338 Communication operation command source</th><th colspan="3">0: NET</th><th colspan="3">1: External</th><th rowspan="2">Remarks</th></tr>
<tr><th colspan="2">Pr.339 Communication speed command source</th><th>0: NET</th><th>1: External</th><th>2: External</th><th>0: NET</th><th>1: External</th><th>2: External</th></tr>
<tr><td colspan="3" rowspan="3">Fixed function (terminal-equivalent function)</td><td colspan="2">Running speed from communication</td><td>NET</td><td>—</td><td>NET</td><td>NET</td><td>—</td><td>NET</td><td></td></tr>
<tr><td colspan="2">Terminal 2</td><td>—</td><td>External</td><td>—</td><td>—</td><td>External</td><td>—</td><td></td></tr>
<tr><td colspan="2">Terminal 4</td><td>—</td><td colspan="2">External</td><td>—</td><td colspan="2">External</td><td></td></tr>
<tr><td rowspan="30">Selective function</td><td rowspan="30">Pr.178 to Pr.184 setting</td><td>0</td><td>RL</td><td>Low-speed operation command/remote setting clear</td><td>NET</td><td colspan="2">External</td><td>NET</td><td colspan="2">External</td><td rowspan="3">Pr.59 = "0" (multi-speed)
Pr.59 = "1, 2" (remote)</td></tr>
<tr><td>1</td><td>RM</td><td>Middle-speed operation command/remote setting function</td><td>NET</td><td colspan="2">External</td><td>NET</td><td colspan="2">External</td></tr>
<tr><td>2</td><td>RH</td><td>High-speed operation command/remote setting function</td><td>NET</td><td colspan="2">External</td><td>NET</td><td colspan="2">External</td></tr>
<tr><td>3</td><td>RT</td><td>Second function selection</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>4</td><td>AU</td><td>Terminal 4 input selection</td><td>—</td><td colspan="2">Combined</td><td>—</td><td colspan="2">Combined</td><td></td></tr>
<tr><td>5</td><td>JOG</td><td>Jog operation selection</td><td colspan="3">—</td><td colspan="3">External</td><td></td></tr>
<tr><td>7</td><td>OH</td><td>External thermal relay input</td><td colspan="6">External</td><td></td></tr>
<tr><td>8</td><td>REX</td><td>15-speed selection</td><td>NET</td><td colspan="2">External</td><td>NET</td><td colspan="2">External</td><td>Pr.59 = "0" (multi-speed)</td></tr>
<tr><td>10</td><td>X10</td><td>Drive unit run enable signal</td><td colspan="6">External</td><td></td></tr>
<tr><td>12</td><td>X12</td><td>PU operation external interlock</td><td colspan="6">External</td><td></td></tr>
<tr><td>14</td><td>X14</td><td>PID control valid terminal</td><td>NET</td><td colspan="2">External</td><td>NET</td><td colspan="2">External</td><td></td></tr>
<tr><td>16</td><td>X16</td><td>PU/External operation switchover</td><td colspan="6">External</td><td></td></tr>
<tr><td>23</td><td>LX</td><td>Pre-excitation</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td rowspan="2">24</td><td rowspan="2">MRS</td><td>Output stop</td><td colspan="3">Combined</td><td colspan="3">External</td><td>Pr.79 ≠ "7"</td></tr>
<tr><td>PU operation interlock</td><td colspan="6">External</td><td>Pr.79 = "7"
When the X12 signal is not assigned</td></tr>
<tr><td>25</td><td>STOP</td><td>Start self-holding selection</td><td colspan="3">—</td><td colspan="3">External</td><td></td></tr>
<tr><td>29</td><td>X29</td><td>Stopper control switchover</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>30</td><td>JOG2</td><td>Jog operation selection 2</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>44</td><td>X44</td><td>P/PI control switchover</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>60</td><td>STF</td><td>Forward rotation command</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>61</td><td>STR</td><td>Reverse rotation command</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>62</td><td>RES</td><td>Drive unit Reset</td><td colspan="6">External</td><td></td></tr>
<tr><td>65</td><td>X65</td><td>PU/NET operation switchover</td><td colspan="6">External</td><td></td></tr>
<tr><td>66</td><td>X66</td><td>External/NET operation switchover</td><td colspan="6">External</td><td></td></tr>
<tr><td>67</td><td>X67</td><td>Command source switchover</td><td colspan="6">External</td><td></td></tr>
<tr><td>76</td><td>X76</td><td>Proximity dog</td><td colspan="3">Combined</td><td colspan="3">External</td><td></td></tr>
<tr><td>86</td><td>SON</td><td>Servo-ON</td><td colspan="3">NET</td><td colspan="3">External</td><td></td></tr>
<tr><td>87</td><td>X87</td><td>Position control sudden stop</td><td colspan="3">Combined</td><td colspan="3">External</td><td></td></tr>
<tr><td>88</td><td>LSP</td><td>Forward stroke end</td><td colspan="3">Combined</td><td colspan="3">External</td><td></td></tr>
<tr><td>89</td><td>LSN</td><td>Reverse stroke end</td><td colspan="3">Combined</td><td colspan="3">External</td><td></td></tr>
</table>

[Explanation of table]

External : Command is valid only from control terminal.
NET : Command only from communication is valid
Combined : Command from both control terminal and communication is valid.
— : Command from either of control terminal and communication is invalid.

REMARKS

- The command source of communication is as set in *Pr.550* and *Pr.551*.
- The *Pr.338* and *Pr.339* settings can be changed while the drive unit is running when *Pr.77* = "2". Note that the setting change is reflected after the drive unit has stopped. Until the drive unit has stopped, communication operation command source and communication speed command source before the setting change are valid.

(6) Switching of command source by external signal (X67)

- In the Network operation mode, the Command source switchover signal (X67) can be used to switch the start command source and speed command source.
- Set "67" to any of *Pr.178 to Pr.184 (input terminal function selection)* to assign the X67 signal to the control terminal.
- When the X67 signal is OFF, the start command source and speed command source are control terminal.

X67 Signal State	Start Command Source	Speed Command Source
No signal assignment	According to *Pr.338*	According to *Pr.339*
ON		
OFF	Command is valid only from control terminal.	

REMARKS

- The ON/OFF state of the X67 signal is reflected only during a stop. It is reflected after a stop when the terminal is switched while the drive unit is running.
- When the X67 signal is OFF, a reset via communication is disabled.

NOTE

- **Changing the terminal assignment using *Pr.178 to Pr.184 (input terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.59 Remote function selection ☞ *Refer to page 122*
Pr.79 Operation mode selection ☞ *Refer to page 186*

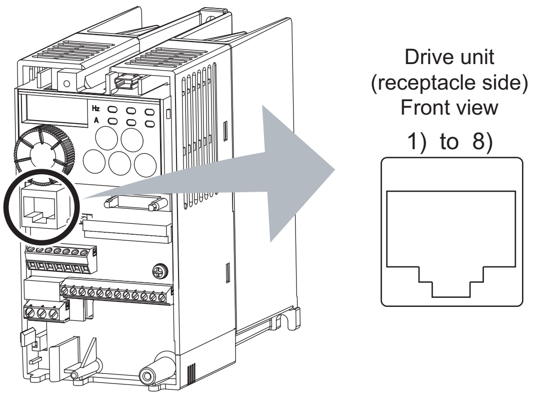
4.18 Communication operation and setting

Purpose	Parameter to set		Refer to page
To perform communication operation from PU connector	Initial setting of computer link communication (PU connector)	Pr.117 to Pr.124	*204*
	Modbus-RTU communication specifications	Pr.117, Pr.118, Pr.120, Pr.122, Pr.343, Pr.502, Pr.549	*222*
To restrict parameter write through communication	Communication EEPROM write selection	Pr.342	*208*

4.18.1 Wiring and configuration of PU connector

Using the PU connector, you can perform communication operation from a personal computer etc.
When the PU connector is connected with a personal, FA or other computer by a communication cable, a user program can run and monitor the drive unit or read and write to parameters.

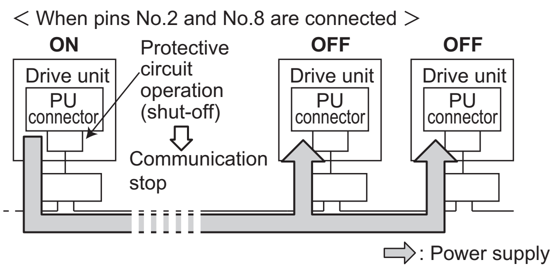
(1) PU connector pin-outs



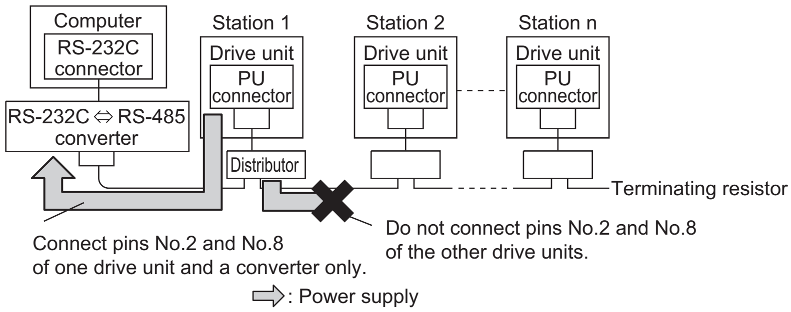
Pin Number	Name	Description
1)	SG	Earth (ground) (connected to terminal 5)
2)	—	Parameter unit power supply
3)	RDA	Drive unit receive+
4)	SDB	Drive unit send-
5)	SDA	Drive unit send+
6)	RDB	Drive unit receive-
7)	SG	Earth (ground) (connected to terminal 5)
8)	—	Earth (ground) (connected to terminal 5)

NOTE

- **Pins No. 2 and 8 provide power to the parameter unit. Do not use these pins for RS-485 communication.**
- **When making RS-485 communication with a combination of the FR-E700EX series, FR-E500 series, and FR-S500 series, incorrect connection of pins No.2 and 8 (parameter unit power supply) of the above PU connector may result in a malfunction or failure of the inverter or drive unit.**
- **When multiple drive units are connected using pins No.2 and No.8, power is provided from the drive unit which is powered ON to the drive units which are powered OFF in case drive units which are powered ON and OFF are mixed. In such a case, a protective circuit of the drive unit, which is ON, functions to stop communication. When connecting multiple drive units for RS-485 communication, make sure to disconnect cables from No.2 and No.8 so that pins No.2 and No.8 are not connected between drive units.**



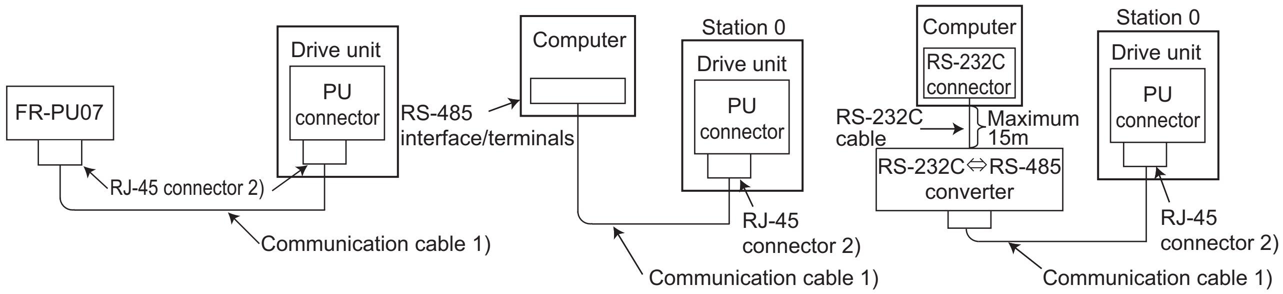
- **When using the RS-485 converter which receives power from the drive unit, make sure that power is provided from one drive unit only.** *(Refer to the figure below.)*



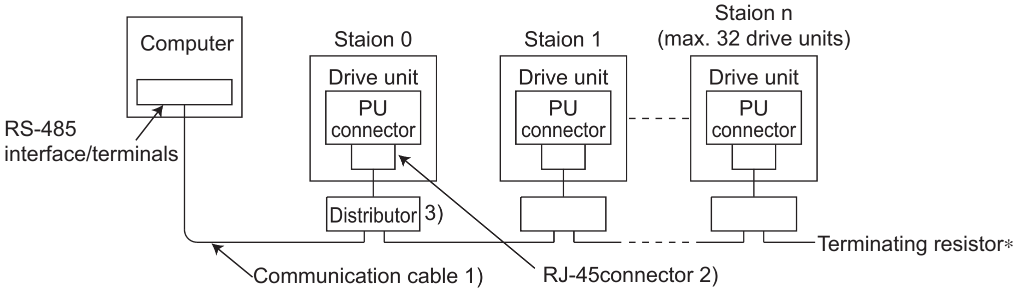
- **Do not connect the PU connector to the computer's LAN board, FAX modem socket or telephone modular connector. The product could be damaged due to differences in electrical specifications.**

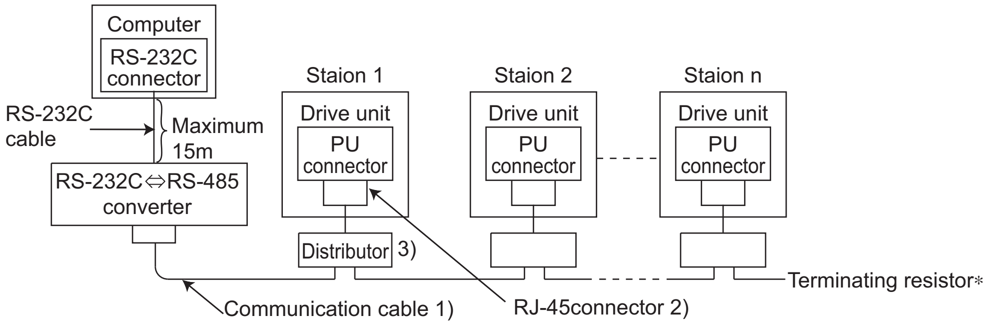
(2) PU connector communication system configuration

● Connection of a computer to the drive unit (1:1 connection)



● Combination of a computer and multiple drive units (1:n connection)





* The drive units may be affected by reflection depending on the transmission speed or transmission distance. If this reflection hinders communication, provide a terminating resistor. If the PU connector is used to make a connection, use a distributor since a terminating resistor cannot be fitted. Connect the terminating resistor to only the drive unit remotest from the computer. (Terminating resistor: 100Ω)

REMARKS

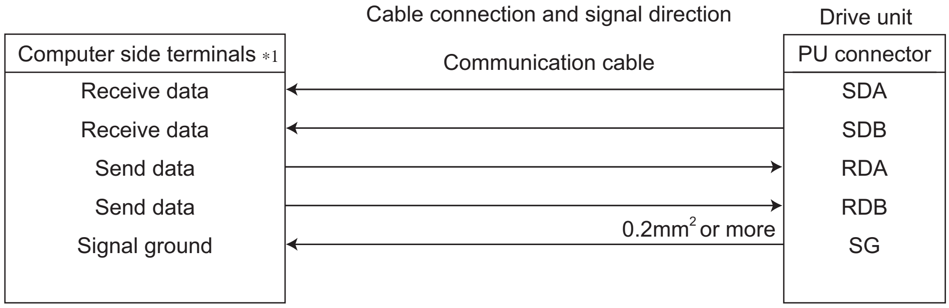
- Refer to the following when fabricating the cable on the user side.
  Examples of product available on the market (as of February 2012)

Product		Type	Maker
1)	Communication cable	SGLPEV-T (Cat5e/300m) 24AWG × 4P *1	Mitsubishi Cable Industries, Ltd.
2)	RJ-45 connector	5-554720-3	Tyco Electronics Corporation

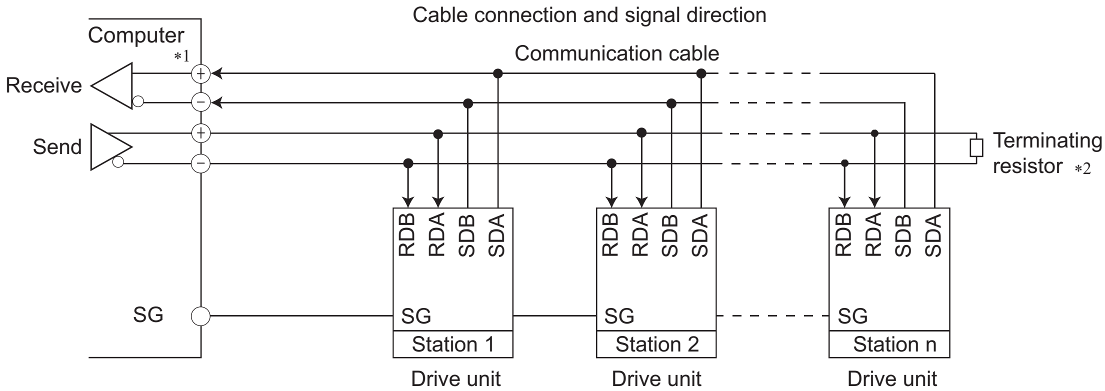
*1 Do not use pins No. 2, 8 of the communication cable. *(Refer to page 201)*

(3) Connection with RS-485 computer

●Wiring of one RS-485 computer and one drive unit



●Wiring of one RS-485 computer and "n" (multiple) drive units



*1 Make connection in accordance with the instruction manual of the computer to be used with. Fully check the terminal numbers of the computer since they vary with the model.

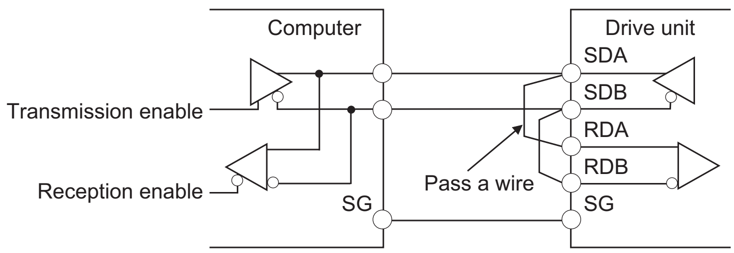
*2 The drive units may be affected by reflection depending on the transmission speed or transmission distance. If this reflection hinders communication, provide a terminating resistor. If the PU connector is used to make a connection, use a distributor since a terminating resistor cannot be fitted. Connect the terminating resistor to only the drive unit remotest from the computer. (Terminating resistor: 100Ω)

NOTE

- **Do not use pins No. 2, 8 of the communication cable.** *(Refer to page 201)*
- **When making RS-485 communication with a combination of the FR-E700EX series, FR-E500 series, and FR-S500 series, incorrect connection of pins No.2 and 8 (parameter unit power supply) of the above PU connector may result in a malfunction or failure of the inverter or drive unit.**
  (Refer to page 201)

(4) Two-wire type connection

If the computer is 2-wire type, a connection from the drive unit can be changed to 2-wire type by passing wires across reception terminals and transmission terminals of the PU connector pin.



REMARKS

- A program should be created so that transmission is disabled (receiving state) when the computer is not sending and reception is disabled (sending state) during sending to prevent the computer from receiving its own data.
- The passed wiring length should be as short as possible.

4.18.2 Initial settings and specifications of RS-485 communication (Pr.117 to Pr.120, Pr.123, Pr.124, Pr.549)

Used to perform required settings for RS-485 communication between the drive unit and personal computer.

- Use PU connector of the drive unit for communication.
- You can perform parameter setting, monitoring, etc. using Mitsubishi inverter protocol or Modbus-RTU protocol.
- To make communication between the personal computer and drive unit, initialization of the communication specifications must be made to the drive unit.
  Data communication cannot be made if the initial settings are not made or there is any setting error.

<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th colspan="2">Description</th></tr>
<tr><td>117</td><td>PU communication station number</td><td>0</td><td>0 to 31
(0 to 247) *1</td><td colspan="2">Drive unit station number specification
Set the drive unit station numbers when two or more drive units are connected to one personal computer.</td></tr>
<tr><td>118</td><td>PU communication speed</td><td>192</td><td>48, 96, 192, 384</td><td colspan="2">Communication speed
The setting value × 100 equals the communication speed.
Example)19200bps if 192</td></tr>
<tr><td rowspan="5">119</td><td rowspan="5">PU communication stop bit length</td><td rowspan="5">1</td><td></td><td>Stop bit length</td><td>Data length</td></tr>
<tr><td>0</td><td>1 bit</td><td rowspan="2">8 bit</td></tr>
<tr><td>1</td><td>2 bit</td></tr>
<tr><td>10</td><td>1 bit</td><td rowspan="2">7 bit</td></tr>
<tr><td>11</td><td>2 bit</td></tr>
<tr><td rowspan="3">120</td><td rowspan="3">PU communication parity check</td><td rowspan="3">2</td><td>0</td><td colspan="2">Without parity check</td></tr>
<tr><td>1</td><td colspan="2">Without parity check</td></tr>
<tr><td>2</td><td colspan="2">With even parity check</td></tr>
<tr><td rowspan="2">123</td><td rowspan="2">PU communication waiting time</td><td rowspan="2">9999</td><td>0 to 150ms</td><td colspan="2">Set the waiting time between data transmission to the drive unit and response.</td></tr>
<tr><td>9999</td><td colspan="2">Set with communication data.</td></tr>
<tr><td rowspan="3">124</td><td rowspan="3">PU communication CR/LF selection</td><td rowspan="3">1</td><td>0</td><td colspan="2">Without CR/LF</td></tr>
<tr><td>1</td><td colspan="2">With CR</td></tr>
<tr><td>2</td><td colspan="2">With CR/LF</td></tr>
<tr><td rowspan="2">549</td><td rowspan="2">Protocol selection</td><td rowspan="2">0</td><td>0</td><td colspan="2">Mitsubishi inverter (computer link operation) protocol</td></tr>
<tr><td>1</td><td colspan="2">Modbus-RTU protocol</td></tr>
</table>

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 When "1" (Modbus-RTU protocol) is set in *Pr.549* , the setting range within parenthesis is applied.

NOTE

- **Always reset the drive unit after making the initial settings of the parameters. After you have changed the communication-related parameters, communication cannot be made until the drive unit is reset.**

4.18.3 Operation selection at communication error occurrence (Pr.121, Pr.122, Pr.502)

You can select the drive unit operation when a communication line error occurs during RS-485 communication from the PU connector.

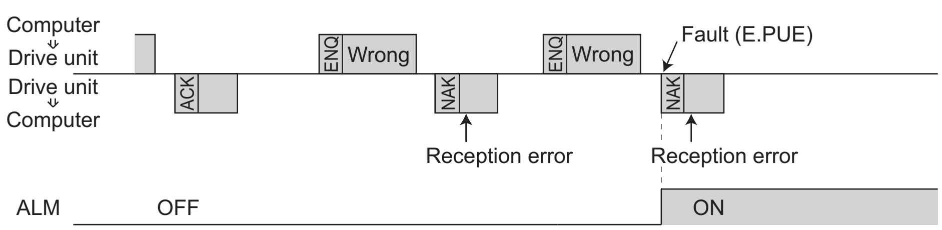
<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th colspan="4">Description</th></tr>
<tr><td rowspan="2">121</td><td rowspan="2">Number of PU communication retries</td><td rowspan="2">1</td><td>0 to 10</td><td colspan="4">Number of retries at data receive error occurrence If the number of consecutive errors exceeds the permissible value, the drive unit trips (depends on Pr.502).
Valid only Mitsubishi inverter (computer link operation) protocol</td></tr>
<tr><td>9999</td><td colspan="4">If a communication error occurs, the drive unit will not come to trip.</td></tr>
<tr><td rowspan="3">122</td><td rowspan="3">PU communication check time interval</td><td rowspan="3">0</td><td>0</td><td colspan="4">RS-485 communication can be made. Note that a communication fault (E.PUE) occurs as soon as the drive unit is switched to the operation mode with command source.</td></tr>
<tr><td>0.1 to 999.8s</td><td colspan="4">Communication check (signal loss detection) time interval If a no-communication state persists for longer than the permissible time, the drive unit trips (depends on Pr.502).</td></tr>
<tr><td>9999</td><td colspan="4">No communication check (signal loss detection)</td></tr>
<tr><td rowspan="4">502</td><td rowspan="4">Stop mode selection at communication error</td><td rowspan="4">0</td><td></td><th>At fault occurrence</th><th>Indication</th><th>Fault output</th><th>At fault removal</th></tr>
<tr><td>0, 3</td><td>Coasts to stop</td><td>E.PUE</td><td>Output</td><td>Stop (E.PUE)</td></tr>
<tr><td>1</td><td>Decelerates to stop</td><td>After stop E.PUE</td><td>Output after stop</td><td>Stop (E.PUE)</td></tr>
<tr><td>2</td><td>Decelerates to stop</td><td>After stop E.PUE</td><td>Without output</td><td>Automatic restart functions</td></tr>
</table>

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

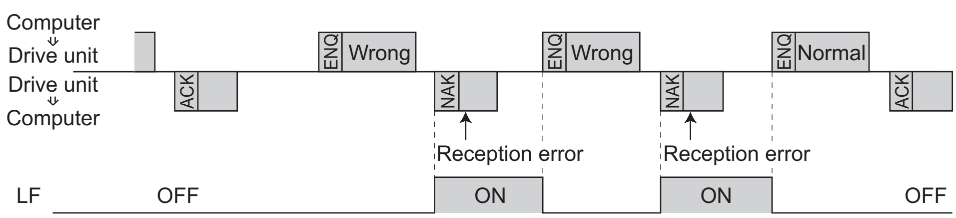
(1) Retry count setting *(Pr.121)*

- Set the permissible number of retries at data receive error occurrence. (*Refer to page 213* for data receive error for retry)
- When data receive errors occur consecutively and exceed the permissible number of retries set, a drive unit trips (E.PUE) and a motor stops (as set in *Pr.502*).
- When "9999" is set, a drive unit fault is not provided even if data receive error occurs but an alarm signal (LF) is output. For the terminal used for the LF signal output, assign the function by setting "98 (positive logic) or 198 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*.

Example: PU connector communication, *Pr.121* = "1" (initial value)



Example: PU connector communication, *Pr.121* = "9999"



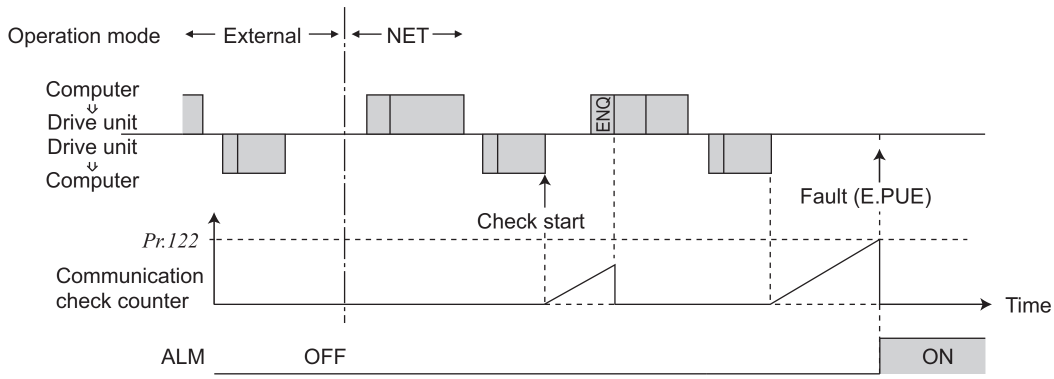
REMARKS

- *Pr.121* is valid only when Mitsubishi inverter (computer link operation) protocol is selected. *Pr.121* is not valid when Modbus-RTU communication protocol is selected.
- How the drive unit operates at a communication error differs according to the *Pr. 502 Stop mode selection at communication error* setting.

(2) Signal loss detection *(Pr.122)*

- If a signal loss (communication stop) is detected between the drive unit and master as a result of a signal loss detection, a communication fault (E.PUE) occurs and the drive unit trips. (as set in *Pr.502*).
- When the setting is "9999", communication check (signal loss detection) is not made.
- When the setting value is "0" (initial value), RS-485 communication can be made. However, a communication fault (E.PUE) occurs as soon as the drive unit is switched to the operation mode (Network operation mode in the initial setting) with the command source.
- A signal loss detection is made when the setting is any of "0.1s to 999.8s". To make a signal loss detection, it is necessary to send data (refer to Mitsubishi inverter protocol control code (*Refer to page 212*), Modbus-RTU communication protocol (*Refer to page 223*)) from the computer within the communication check time interval. (The drive unit makes communication check (clearing of communication check counter) regardless of the station number setting of the data sent from the master).
- Communication check is made from the first communication in the operation mode with command source valid (Network operation mode in the initial setting).

Example: PU connector communication, *Pr.122* = "0.1 to 999.8s"



⚠ CAUTION

⚠ **Always set the communication check time interval before starting operation to prevent hazardous conditions. Data communication is not started automatically but is made only once when the computer provides a communication request. If communication is disabled during operation due to signal cable breakage etc., the drive unit cannot be stopped. When the communication check time interval has elapsed, the drive unit trips (E.PUE).**
The motor can be coasted to a stop by turning ON its RES signal or by switching power OFF.

⚠ **If communication is broken due to signal cable breakage, computer fault, etc. the drive unit does not detect such a fault. This should be fully noted.**

(3) Stop operation selection at occurrence of communication fault *(Pr.502)*

- Stop operation when retry count excess (Mitsubishi inverter protocol only) or signal loss detection error occurs can be selected.

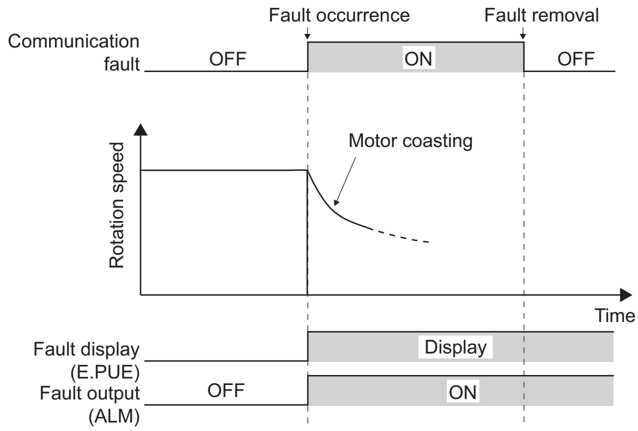
  Operation at fault occurrence

Pr.502 Setting	Operation	Indication	Fault Output
0 (initial value)	Coasts to stop.	E. PUE lit	Provided
1	Decelerates to stop	E. PUE lit after stop	Provided after stop
2			Not provided
3	Same as the setting "0"		

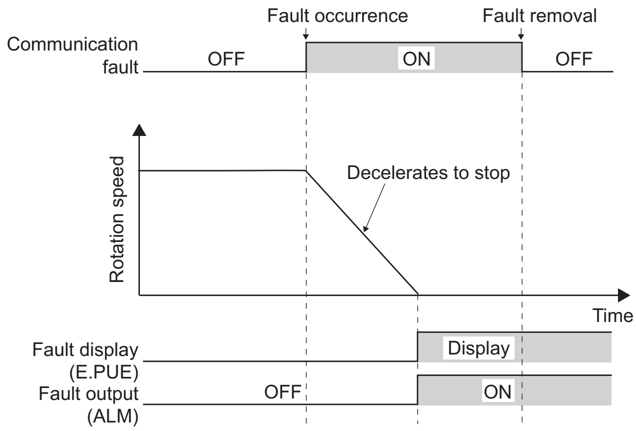
  Operation at fault removal

Pr.502 Setting	Operation	Indication	Fault Output
0 (initial value)	Kept provided	E. PUE	Kept provided
1			
2	Automatic restart functions	Normal display	Not provided
3	Same as the setting "0"		

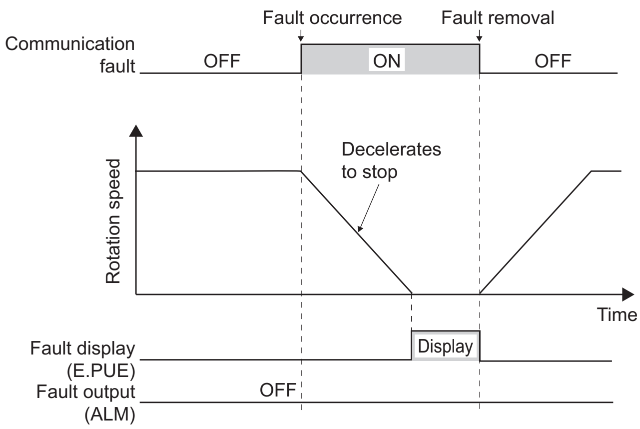
●*Pr.502* setting "0 (initial value), 3"



●*Pr.502* setting "1"



●*Pr.502* setting "2"



REMARKS

- The fault output indicates fault output signal (ALM signal) or alarm bit output.
- When the setting was made to provide a fault output, the fault description is stored into the faults history. (The fault description is written to the faults history when a fault output is provided.)
  When no fault output is provided, the fault record overwrites the fault indication of the faults history temporarily, but is not stored. After the fault is removed, the fault indication returns to the ordinary monitor, and the faults history returns to the preceding fault indication.
- When the *Pr.502* setting is "1 or 2", the deceleration time is the ordinary deceleration time setting (e.g. *Pr.8, Pr.44, Pr.45*). In addition, acceleration time for restart is the normal acceleration time (e.g. *Pr.7, Pr.44*).
- When "2" is set in *Pr.502*, run command/speed command at restarting follows the command before an fault occurrence.
- When "2" is set in *Pr.502* at occurrence of a communication error and the error is removed during deceleration, the motor accelerates again at that point.

Parameters referred to

Pr.7 Acceleration time, Pr.8 Deceleration time *Refer to page 125*
Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.18.4 Communication EEPROM write selection (Pr.342)

When parameter write is performed from the drive unit PU connector, USB communication, and communication option, parameters storage device can be changed from EEPROM + RAM to RAM only. Set when a frequent parameter change is necessary.

Parameter number	Name	Initial value	Setting range	Description
342	**Communication EEPROM write selection**	0	0	Parameter values written by communication are written to the EEPROM and RAM.
			1	Parameter values written by communication are written to RAM.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". However, it can be set any time when the communication option is connected. (*Refer to page 182*)

- When changing the parameter values frequently, set "1" in *Pr.342* to write them to the RAM only.
  The life of the EEPROM will be shorter if parameter write is performed frequently with the setting unchanged from "0 (initial value)" (EEPROM write).

REMARKS

- When "1" (write to RAM only) is set in *Pr.342*, powering off the drive unit will erase the changed parameter values. Therefore, the parameter values available when power is switched on again are the values stored in EEPROM previously.
- The read values on the operation panel are the values stored in EEPROM. If a value is changed in RAM only, the value may be different from the read value on the operation panel.

4.18.5 Mitsubishi inverter protocol (computer link communication)

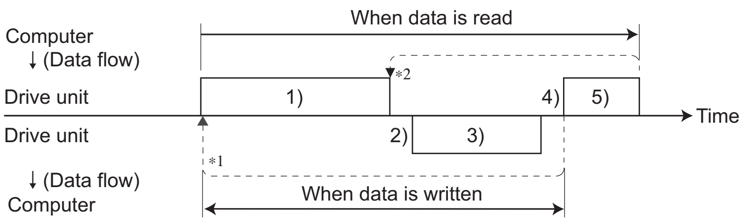
You can perform parameter setting, monitor, etc. from the PU connector of the drive unit using the Mitsubishi inverter protocol (computer link communication).

(1) Communication

- The communication specifications are given below.

Item		Description	Related parameter
Communication protocol		Mitsubishi protocol (computer link)	Pr.549
Conforming standard		EIA-485 (RS-485)	—
Number of connectable devices		1:N (maximum 32 units), setting is 0 to 31 stations	Pr.117
Communication speed	PU connector	Selected among 4800/9600/19200/38400bps	Pr.118
Control procedure		Asynchronous	—
Communication method		Half-duplex	—
Communication	Character system	ASCII (7 bits or 8 bits can be selected)	Pr.119
	Start bit	1 bit	—
	Stop bit length	1 bit or 2 bits can be selected	Pr.119
	Parity check	Check (with even or odd parity) or no check can be selected	Pr.120
	Error check	Sum code check	—
	Terminator	CR/LF (presence/absence selectable)	Pr.124
Waiting time setting		Selectable between presence and absence	Pr.123

(2) Communication procedure



- Data communication between the computer and drive unit is made in the following procedure.
  1) Request data is sent from the computer to the drive unit. (The drive unit will not send data unless requested.)
  2) After waiting for the waiting time
  3) The drive unit sends reply data to the computer in response to the computer request.
  4) After waiting for the drive unit data processing time
  5) Answer from the computer in response to reply data 3) of the drive unit is transmitted. (Even if 5) is not sent, subsequent communication is made properly.)

*1 If a data error is detected and a retry must be made, execute retry operation with the user program. The drive unit comes to trip if the number of consecutive retries exceeds the parameter setting.

*2 On receipt of a data error occurrence, the drive unit returns retry data 3) to the computer again. The drive unit comes to trip if the number of consecutive data errors reaches or exceeds the parameter setting.

(3) Communication operation presence/absence and data format types

- Data communication between the computer and drive unit is made in ASCII code (hexadecimal code).
- Communication operation presence/absence and data format types are as follows:

<table>
<tr><th>No.</th><th colspan="2">Operation</th><th>Run Command</th><th>Operation speed</th><th>Multi command</th><th>Parameter Write</th><th>Drive unit reset</th><th>Monitor</th><th>Parameter Read</th></tr>
<tr><td>1)</td><td colspan="2">Communication request is sent to the drive unit in accordance with the user program in the computer.</td><td>A1</td><td>A, A2 *3</td><td>A3</td><td>A, A2 *3</td><td>A</td><td>B</td><td>B</td></tr>
<tr><td>2)</td><td colspan="2">Drive unit data processing time</td><td>Present</td><td>Present</td><td>Present</td><td>Present</td><td>Present</td><td>Present</td><td>Present</td></tr>
<tr><td rowspan="2">3)</td><td rowspan="2">Reply data from the drive unit (Data 1) is checked for error)</td><td>No error *1 (Request accepted)</td><td>C</td><td>C</td><td>C1 *4</td><td>C</td><td>C *2</td><td>E, E1, E2, E3 *3</td><td>E, E2 *3</td></tr>
<tr><td>With error. (Request rejected)</td><td>D</td><td>D</td><td>D</td><td>D</td><td>D *2</td><td>D</td><td>D</td></tr>
<tr><td>4)</td><td colspan="2">Computer processing delay time</td><td colspan="7">10ms or more</td></tr>
<tr><td rowspan="2">5)</td><td rowspan="2">Answer from computer in response to reply data 3). (Data 3) is checked for error)</td><td>No error *1 (No drive unit processing)</td><td>Absent</td><td>Absent</td><td>Absent (C)</td><td>Absent</td><td>Absent</td><td>Absent (C)</td><td>Absent (C)</td></tr>
<tr><td>With error. (Drive unit outputs 3) again.)</td><td>Absent</td><td>Absent</td><td>F</td><td>Absent</td><td>Absent</td><td>F</td><td>F</td></tr>
</table>

*1 In the communication request data from the computer to the drive unit, 10ms or more is also required after "no data error (ACK)". *(Refer to page 212)*
*2 Reply from the drive unit to the drive unit reset request can be selected. *(Refer to page 216)*
*3 When any of "0.01 to 9998" is set in *Pr.37* and "01" in instruction code HFF sets data format to A2 or E2. In addition, data format is always A2 and E2 for read or write of *Pr.37*.
*4 At mode error, and data range error, C1 data contains an error code. *(Refer to page 221)* Except for those errors, the error is returned with data format D.

- Data writing format

Communication request data from the computer to the drive unit 1)

<table>
<tr><th rowspan="2">Format</th><th colspan="19">Number of Characters</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th></tr>
<tr><td>A</td><td>ENQ *1</td><td colspan="2">Drive unit station number *2</td><td colspan="2">Instruction code</td><td>*3</td><td colspan="4">Data</td><td colspan="2">Sum check</td><td>*4</td><td colspan="6"></td></tr>
<tr><td>A1</td><td>ENQ *1</td><td colspan="2">Drive unit station number *2</td><td colspan="2">Instruction code</td><td>*3</td><td colspan="2">Data</td><td colspan="2">Sum check</td><td>*4</td><td colspan="8"></td></tr>
<tr><td>A2</td><td>ENQ *1</td><td colspan="2">Drive unit station number *2</td><td colspan="2">Instruction code</td><td>*3</td><td colspan="6">Data</td><td colspan="2">Sum check</td><td>*4</td><td colspan="4"></td></tr>
<tr><td>A3</td><td>ENQ *1</td><td colspan="2">Drive unit station number *2</td><td colspan="2">Instruction code</td><td>*3</td><td>Send data type</td><td>Receive data type</td><td colspan="4">Data1</td><td colspan="4">Data2</td><td colspan="2">Sum check</td><td>*4</td></tr>
</table>

Reply data from the drive unit to the computer 3) (No data error detected)

<table>
<tr><th rowspan="2">Format</th><th colspan="19">Number of Characters</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>18</th><th>19</th></tr>
<tr><td>C</td><td>ACK *1</td><td colspan="2">Drive unit station number *2</td><td>*4</td><td colspan="15"></td></tr>
<tr><td>C1</td><td>STX *1</td><td colspan="2">Drive unit station number *2</td><td>Send data type</td><td>Receive data type</td><td>Error code 1</td><td>Error code 2</td><td colspan="4">Data1</td><td colspan="4">Data2</td><td>ETX *1</td><td colspan="2">Sum check</td><td>*4</td></tr>
</table>

Reply data from the drive unit to the computer 3) (With data error)

<table>
<tr><th rowspan="2">Format</th><th colspan="5">Number of Characters</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr><td>D</td><td>NAK *1</td><td colspan="2">Drive unit station number *2</td><td>Error code</td><td>*4</td></tr>
</table>

*1 Indicate a control code
*2 Specify the drive unit station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.
*3 When the *Pr.123 PU communication waiting time* is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)
*4 CR, LF code
When data is transmitted from the computer to the drive unit, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the drive unit according to the computer. Whether the CR and LF codes will be present or absent can be selected using *Pr.124 PU communication CR/LF selection*.

- Data reading format

Communication request data from the computer to the drive unit 1)

Format	Number of Characters								
	1	2	3	4	5	6	7	8	9
B	ENQ *1	Drive unit station number *2		Instruction code		*3	Sum check		*4

Reply data from the drive unit to the computer 3) (No data error detected)

Format	Number of Characters												
	1	2	3	4	5	6	7	8	9	10	11	12	13
E	STX *1	Drive unit station number *2		Read data				ETX *1	Sum check		*4		
E1	STX *1	Drive unit station number *2		Read data		ETX *1	Sum check		*4				
E2	STX *1	Drive unit station number *2		Read data						ETX *1	Sum check		*4

Format	Number of Characters							
	1	2	3	4 to 23	24	25	26	27
E3	STX *1	Drive unit station number *2		Read data (Drive unit type information)	ETX *1	Sum check		*4

Reply data from the drive unit to the computer 3) (With data error)

Format	Number of Characters				
	1	2	3	4	5
D	NAK *1	Drive unit station number *2		Error code	*4

Send data from the computer to the drive unit 5)

Format	Number of Characters			
	1	2	3	4
C (Without data error)	ACK *1	Drive unit station number *2		*4
F (With data error)	NAK *1	Drive unit station number *2		*4

*1 Indicate a control code

*2 Specify the drive unit station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 When the *Pr.123 PU communication waiting time* is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the drive unit, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the drive unit according to the computer. Whether the CR and LF codes will be present or absent can be selected using *Pr.124 PU communication CR/LF selection*.

(4) Data definitions

1) Control code

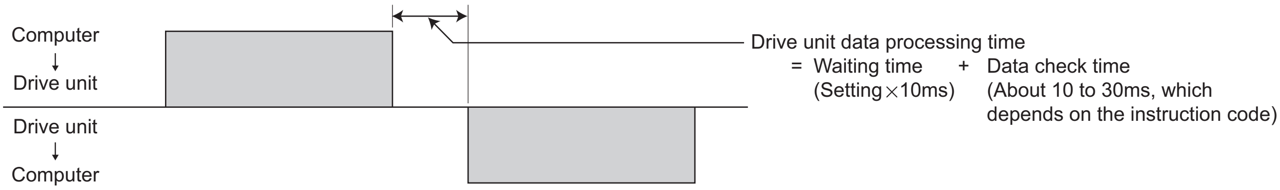
Signal	ASCII Code	Description
STX	H02	Start Of Text (Start of data)
ETX	H03	End Of Text (End of data)
ENQ	H05	Enquiry (Communication request)
ACK	H06	Acknowledge (No data error detected)
LF	H0A	Line Feed
CR	H0D	Carriage Return
NAK	H15	Negative Acknowledge (Data error detected)

2) Drive unit station number
Specify the station number of the drive unit which communicates with the computer.

3) Instruction code
Specify the processing request, e.g. operation or monitoring, given by the computer to the drive unit. Hence, the drive unit can be run and monitored in various ways by specifying the instruction code as appropriate. *(Refer to page 52)*

4) Data
Indicates the data such as speed and parameters transferred to and from the drive unit. The definitions and ranges of set data are determined in accordance with the instruction codes. *(Refer to page 52)*

5) Waiting time
Specify the waiting time between the receipt of data at the drive unit from the computer and the transmission of reply data. Set the waiting time in accordance with the response time of the computer between 0 and 150ms in 10ms increments. (e.g. 1 = 10ms, 2 = 20ms).



REMARKS

- When the *Pr.123, Pr.337 (waiting time setting)* setting is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)
- The data check time changes depending on the instruction code. *(Refer to page 213)*

6) Sum check code
The sum check code is 2-digit ASCII (hexadecimal) representing the lower 1 byte (8 bits) of the sum (binary) derived from the checked ASCII data.

(Example 1)
Computer → Drive unit

	ENQ	Station number		Instruction code		Waiting time	Data				Sum check code		
		0	1	E	1	*1	0	7	A	D	F	4	← Binary code
ASCII Code →	H05	H30	H31	H45	H31	H31	H30	H37	H41	H44	H46	H34	

H30+H31+H45+H31+H31+H30+H37+H41+H44
=H1F4
Sum

* When the *Pr.123 PU communication waiting time* ≠ "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

(Example 2)
Drive unit → Computer

	STX	Station number		Data read				ETX	Sum check code		
		0	1	1	7	7	0		3	0	← Binary code
ASCII Code →	H02	H30	H31	H31	H37	H37	H30	H03	H33	H30	

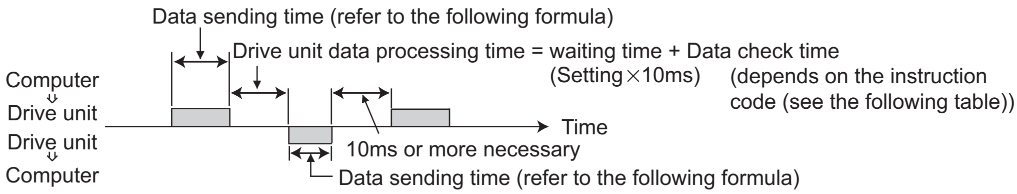
H30+H31+H31+H37+H37+H30
= H130
Sum

7) Error code

If any error is found in the data received by the drive unit, its definition is sent back to the computer together with the NAK code.

Error Code	Error Item	Error Description	Drive Unit Operation
H0	Computer NAK error	The number of errors consecutively detected in communication request data from the computer is greater than allowed number of retries.	Brought to trip (E. PUE) if error occurs continuously more than the allowable number of retry times.
H1	Parity error	The parity check result does not match the specified parity	
H2	Sum check error	The sum check code in the computer does not match that of the data received by the drive unit.	
H3	Protocol error	The data received by the drive unit has a grammatical mistake. Alternatively, data receive is not completed within the predetermined time. CR or LF is not as set in the parameter.	
H4	Framing error	The stop bit length differs from the initial setting.	
H5	Overrun error	New data has been sent by the computer before the drive unit completes receiving the preceding data.	
H6	—	—	—
H7	Character error	The character received is invalid (other than 0 to 9, A to F, control code).	Does not accept received data but is not brought to trip.
H8	—	—	—
H9	—	—	—
HA	Mode error	Parameter write was attempted in other than the computer link operation mode, when operation command source is not selected or during drive unit operation.	Does not accept received data but is not brought to trip.
HB	Instruction code error	The specified command does not exist.	
HC	Data range error	Invalid data has been specified for parameter write, speed setting, etc.	
HD	—	—	—
HE	—	—	—
HF	—	—	—

(5) Response time



[Formula for data sending time]

$$\frac{1}{\text{Communication speed (bps)}} \times \text{Number of data characters} \times \text{Communication (Total number of bits)} = \text{data send time (s)}$$

Number of data characters *(Refer to page 210)*

Communication (Total number of bits) *(Refer to the following.)*

●Communication specifications

Name		Number of Bits
Stop bit length		1 bit 2 bits
Data length		7 bits 8 bits
Parity check	Present	1 bit
	Absent	0

In addition to the above, 1 start bit is necessary.

Minimum number of total bits.................9 bits

Maximum number of total bits................12 bits

●Data check time

Item	Check Time
Various monitors, operation command, speed setting (RAM)	< 12ms
Parameter read/write, speed setting (EEPROM)	< 30ms
Parameter clear/all clear	< 5s
Reset command	No answer

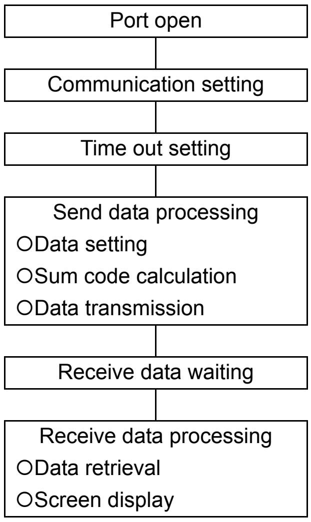
(6) Instructions for the program

1) When data from the computer has any error, the drive unit does not accept that data. Hence, in the user program, always insert a retry program for data error.
2) All data communication, e.g. run command or monitoring, are started when the computer gives a communication request.
   The drive unit does not return any data without the computer's request. Hence, design the program so that the computer gives a data read request for monitoring, etc. as required.
3) Program example
   To change the operation mode to computer link operation

Programming example of Microsoft® Visual C++® (Ver.6.0)

```
#include <stdio.h>
#include <windows.h>

void main(void){
	HANDLE		hCom;		// Communication handle
	DCB		hDcb;		// Structure for communication setting
	COMMTIMEOUTS		hTim;	// Structure for time out setting

	char		szTx[0x10];		// Send buffer
	char		szRx[0x10];		// Receive buffer
	char		szCommand[0x10];// Command
	int		nTx,nRx;		// For buffer size storing
	int		nSum;		// For sum code calculation
	BOOL		bRet;
	int		nRet;
	int		i;

	//**** Opens COM1 port ****
	hCom = CreateFile("COM1", (GENERIC_READ | GENERIC_WRITE), 0, NULL, OPEN_EXISTING, FILE_ATTRIBUTE_NORMAL, NULL);
	if(hCom != NULL) {
		//**** Makes a communication setting of COM1 port ****
		GetCommState(hCom,&hDcb);					// Retrieves current communication information
		hDcb.DCBlength = sizeof(DCB);				// Structure size setting
		hDcb.BaudRate  = 19200;					// Communication speed =19200bps
		hDcb.ByteSize  = 8;					// Data length = 8 bits
		hDcb.Parity    = 2;					// Even parity
		hDcb.StopBits  = 2;					// Stop bit = 2 bits
		bRet = SetCommState(hCom,&hDcb);				// Sets the changed communication data
		if(bRet == TRUE) {
			//**** Makes a time out setting of COM1 port ****
			GetCommTimeouts(hCom,&hTim);			// Obtains the current time out value
			hTim.WriteTotalTimeoutConstant = 1000;		// Write time out 1s
			hTim.ReadTotalTimeoutConstant  = 1000;		// Read time out 1s
			SetCommTimeouts(hCom,&hTim);			// Changed time out value setting
			//**** Sets the command to switch the operation mode of the station 1 drive unit to the network operation mode ****
			sprintf(szCommand,"01FB10000");			// Send data (NET operation write)
			nTx = strlen(szCommand);				// Send data size
			//**** Generates sum code ****
			nSum = 0;						// Initialization of sum data
			for(i = 0;i < nTx;i++) {
				nSum += szCommand[i];			// Calculates sum code
				nSum &= (0xff);				// Masks data
			}

			//**** Generates send data ****
			memset(szTx,0,sizeof(szTx));			// Initialization of send buffer
			memset(szRx,0,sizeof(szRx));			// Initialization of receive buffer
			sprintf(szTx,"\5%s%02X",szCommand,nSum);// ENQÉRÅ[Éh+send data+sum code
			nTx = 1 + nTx + 2;					// Number of ENQ code+number of send data+number of sum code

			nRet = WriteFile(hCom,szTx,nTx,&nTx,NULL);
			//**** Sending ****
			if(nRet != 0) {
				nRet = ReadFile(hCom,szRx,sizeof(szRx),&nRx,NULL);
			//**** Receiving ****
				if(nRet != 0) {
					//**** Displays the receive data ****
					for(i = 0;i < nRx;i++) {
						printf("%02X ",(BYTE)szRx[i]);// Consol output of receive data
						// Displays ASCII coder in hexadecimal. Displays 30 when "0"
					}
					printf("\n\r");
				}
			}
		}
		CloseHandle(hCom);					// Close communication port
	}
}
```

General flowchart



⚠ CAUTION

⚠ **Always set the communication check time interval before starting operation to prevent hazardous conditions. Data communication is not started automatically but is made only once when the computer provides a communication request. If communication is disabled during operation due to signal loss etc., the drive unit cannot be stopped. When the communication check time interval has elapsed, the drive unit will come to trip (E.PUE).**
The motor can be coasted to a stop by switching ON its RES signal or by switching power OFF.

⚠ **If communication is broken due to signal cable breakage, computer fault etc., the drive unit does not detect such a fault. This should be fully noted.**

(7) Setting items and set data

After completion of parameter settings, set the instruction codes and data then start communication from the computer to allow various types of operation control and monitoring.

Item		Read/ Write	Instruction Code	Data Definition	Number of Data Digits (Format) ∗1
Operation mode		Read	H7B	H0000: Network operation H0001: External operation H0002: PU operation	4 digits (B,E/D)
		Write	HFB		4 digits (A,C/D)
Monitor	Rotation speed/output frequency	Read	H6F	H0000 to HFFFF: Rotation speed in 1r/min increments Output frequency increments 0.01Hz (when *Pr.144* = 10 (2, 4, 6, 8)) Machine speed increments 0.001 (when *Pr.37* = 0.01 to 9998)∗2 When "100" is set in *Pr.52*, the monitor value is different depending on whether the drive unit is at a stop or running. *(Refer to page 155)*	4 digits (B,E/D) 6 digits (B,E2/D)
	Output current	Read	H70	H0000 to HFFFF: Output current (hexadecimal) in 0.01A increments	4 digits (B,E/D)
	Output voltage	Read	H71	H0000 to HFFFF: Output voltage (hexadecimal) in 0.1V increments	4 digits (B,E/D)
	Special monitor	Read	H72	H0000 to HFFFF: Monitor data selected in instruction code HF3 ∗2	4 digits (B,E/D) 6 digits (B,E2/D)
	Special monitor Selection No.	Read	H73	H01 to H3F: Monitor selection data Refer to the special monitor No. table *(page 218)*	2 digits (B,E1/D)
		Write	HF3		2 digits (A1,C/D)
	Fault description	Read	H74 to H77	H0000 to HFFFF: Two latest fault records b15 … b8 / b7 … b0 H74: First fault in past / Latest fault H75: Third fault in past / Second fault in past H76: Fifth fault in past / Fourth fault in past H77: Seventh fault in past / Sixth fault in past Refer to the alarm data table *(page 219)*	4 digits (B,E/D)
Run command (expansion)		Write	HF9	Control input commands such as the forward rotation signal (STF) and reverse rotation signal (STR). (For details, refer to *Refer to page 219*)	4 digits (A,C/D)
Run command		Write	HFA		2 digits (A1,C/D)
Drive unit status monitor (expansion)		Read	H79	Monitor the states of the output signals such as forward rotation, reverse rotation and drive unit running (RUN). (For details, refer to *Refer to page 220*)	4 digits (B,E/D)
Drive unit status monitor		Read	H7A		2 digits (B,E1/D)
Set speed (RAM)		Read	H6D	Read the set frequency/speed from RAM or EEPROM. H0000 to HFFFF: speed setting increments 1r/min. Setting frequency increments 0.01Hz (when *Pr.144* = 10 (2, 4, 6, 8)) Machine speed increments 0.001 (when *Pr.37* = 0.01 to 9998) ∗2	4 digits (B,E/D) 6 digits (B,E2/D)
Set speed (EEPROM)			H6E		
Set speed (RAM)		Write	HED	Write the set frequency/speed to RAM or EEPROM. H0000 to HFFFF: speed setting increments 1r/min. Setting frequency increments 0.01Hz (when *Pr.144* = 10 (2, 4, 6, 8)) Machine speed increments 0.001 (when *Pr.37* = 0.01 to 9998)) ∗2 • To change the set speed/frequency consecutively, write data to the drive unit RAM. (Instruction code: HED)	4 digits (A,C/D) 6 digits (A2,C/D)
Set speed (RAM, EEPROM)			HEE		

∗1 *Refer to page 210* for data format (A, A1, A2, A3, B, C, C1, D, E, E1, E2, E3, F)

∗2 The increment is 0.001 and the data format is E2 or A2 when the following conditions are met: *Pr.37* = "0.01 to 9998," *Pr.144* = "2 to 10," and the instruction code HFF = "01."

<table>
<tr><th colspan="2">Item</th><th>Read/ Write</th><th>Instruction Code</th><th>Data Definition</th><th>Number of Data Digits (Format) *1</th></tr>
<tr><td colspan="2" rowspan="2">Drive unit reset</td><td rowspan="2">Write</td><td rowspan="2">HFD</td><td>H9696: resets the drive unit.
• As the drive unit is reset at start of communication by the computer, the drive unit cannot send reply data back to the computer.</td><td>4 digits
(A,C/D)</td></tr>
<tr><td>H9966: resets the drive unit.
• When data is sent normally, ACK is returned to the computer and then the drive unit is reset.</td><td>4 digits
(A,D)</td></tr>
<tr><td colspan="2">Faults history batch clear</td><td>Write</td><td>HF4</td><td>H9696: clears the faults history as a batch.</td><td>4 digits
(A,C/D)</td></tr>
<tr><td colspan="2">Parameter clear
All clear</td><td>Write</td><td>HFC</td><td>All parameters return to the initial values.
Whether to clear communication parameters or not can be selected according to data.
(○: Clear, ×: Not clear)
Refer to page 52 for parameter clear, all clear, and communication parameters.
<table><tr><th>Clear Type</th><th>Data</th><th>Communication Pr.</th></tr><tr><td rowspan="2">Parameter clear</td><td>H9696</td><td>○</td></tr><tr><td>H5A5A</td><td>×*1</td></tr><tr><td rowspan="2">All parameter clear</td><td>H9966</td><td>○</td></tr><tr><td>H55AA</td><td>×*1</td></tr></table>When clear is executed for H9696 or H9966, communication-related parameter settings also return to the initial values. When resuming operation, set the parameters again.
Executing clear will clear the instruction code HEC, HF3, and HFF settings. In the password locked status, only H9966 and H55AA (all parameter clear) are valid.
*1 Turning OFF the power supply while clearing parameters with H5A5A or H55AA also clears the communication parameter settings back to the initial settings.</td><td>4 digits
(A,C/D)</td></tr>
<tr><td colspan="2" rowspan="2">Parameter</td><td>Read</td><td>H00 to H63</td><td rowspan="2">Refer to the instruction code (Refer to page 52) and write and/or read parameter values as required.
When setting Pr.100 and later, link parameter extended setting must be set.
Data format of Pr.37 read and write is E2 and A2</td><td>4 digits
(B,E/D)
6 digits
(B,E2/D)</td></tr>
<tr><td>Write</td><td>H80 to HE3</td><td>4 digits
(A,C/D)
6 digits
(A2,C/D)</td></tr>
<tr><td colspan="2" rowspan="2">Link parameter extended setting</td><td>Read</td><td>H7F</td><td rowspan="2">Parameter description is changed according to the H00 to H09 setting.
For details of the settings, refer to the parameter instruction code (Refer to page 52).</td><td>2 digits
(B,E1/D)</td></tr>
<tr><td>Write</td><td>HFF</td><td>2 digits
(A1,C/D)</td></tr>
<tr><td colspan="2" rowspan="2">Second parameter changing (instruction code HFF = 1, 9)</td><td>Read</td><td>H6C</td><td rowspan="2">Setting calibration parameter (Refer to the list of calibration parameters on the next page for calibration parameters.)
H00: Speed (The gain speed can also be written using Pr.125 (instruction code: H99) or Pr.126 (instruction code: H9A).)
H01: Parameter-set analog value
H02: Analog value input from terminal</td><td>2 digits
(B,E1/D)</td></tr>
<tr><td>Write</td><td>HEC</td><td>2 digits
(A1,C/D)</td></tr>
<tr><td colspan="2">Multi command</td><td>Write/ Read</td><td>HF0</td><td>Available for writing 2 commands, and monitoring 2 items for reading data (Refer to page 221 for detail)</td><td>10 digits
(A3,C1/D)</td></tr>
<tr><td rowspan="2">Drive unit type monitor</td><td>Drive unit type</td><td>Read</td><td>H7C</td><td>Reading drive unit type in ASCII code.
"H20" (blank code) is set for blank area
Example of FR-E720EX
H46, H52, H2D, H45, H37, H32, H30, H45, H58, H20 ..H20</td><td>20 digits
(B,E3/D)</td></tr>
<tr><td>Capacity</td><td>Read</td><td>H7D</td><td>Reading drive unit capacity in ASCII code.
Data is read in increments of 0.1kW, and rounds down to 0.01kW increments
"H20" (blank code) is set for blank area
Example
0.4K .... "   4"(H20, H20, H20, H20, H20, H34)
0.75K .... "   7"(H20, H20, H20, H20, H20, H37)</td><td>6 digits
(B,E2/D)</td></tr>
</table>

*1 *Refer to page 210* for data format (A, A1, A2, A3, B, C, C1, D, E, E1, E2, E3, F)

*2 The increment is 0.001 and the data format is E2 or A2 when the following conditions are met: *Pr.37* = "0.01 to 9998," *Pr.144* = "2 to 10," and the instruction code HFF = "01."

REMARKS

- Set 65520 (HFFF0) as a parameter value "8888" and 65535 (HFFFF) as "9999".
- For the instruction codes HFF, HEC and HF3, their values are held once written but cleared to zero when a drive unit reset or all clear is performed.

Example) When reading the *C3 (Pr.902)* and *C6 (Pr.904)* settings from the drive unit of station 0

	Computer Send Data	Drive Unit Send Data	Description
1)	ENQ 00 FF 0 01 7D	ACK 00	Set "H01" to the expansion link parameter.
2)	ENQ 00 EC 0 01 79	ACK 00	Set "H01" to second parameter changing.
3)	ENQ 00 5E 0 0A	STX 00 0000 ETX 20	*C3(Pr.902)* is read. 0% is read.
4)	ENQ 00 60 0 F6	STX 00 0000 ETX 20	*C6(Pr.904)* is read. 0% is read.

To read/write *C3 (Pr.902)* and *C6 (Pr.904)* after drive unit reset or parameter clear, execute from 1) again.

● List of calibration parameters

Parameter	Name	Instruction Code		
		Read	Write	Extended
C2 (902)	Terminal 2 speed setting bias speed	5E	DE	1
C3 (902)	Terminal 2 speed setting bias	5E	DE	1
125 (903)	Terminal 2 speed setting gain speed	5F	DF	1
C4 (903)	Terminal 2 speed setting gain	5F	DF	1
C5 (904)	Terminal 4 speed setting bias speed	60	E0	1
C6 (904)	Terminal 4 speed setting bias	60	E0	1
126 (905)	Terminal 4 speed setting gain speed	61	E1	1
C7 (905)	Terminal 4 speed setting gain	61	E1	1

[Special monitor selection No.]

Refer to page 156 for details of the monitor description.

Data	Description	Unit
H01	Rotation speed/output frequency/ machine speed *1	1/0.01Hz/0.001
H02	Output current	0.01A
H03	Output voltage	0.1V
H05	Rotation speed setting/frequency setting/ machine speed setting *1	1/0.01Hz/0.001
H08	Converter output voltage	0.1V
H09	Regenerative brake duty	0.1%
H0A	Electronic thermal relay function load factor	0.1%
H0B	Output current peak value	0.01A
H0C	Converter output voltage peak value	0.1V
H0E	Output power	0.01kW
H0F	Input terminal status *2	—
H10	Output terminal status *3	—
H13	Position pulse	—
H14	Cumulative energization time	1h
H17	Actual operation time	1h
H18	Motor load factor	0.1%
H19	Cumulative power	1kWh

Data	Description	Unit
H1A	Position command [before electronic gear] (lower 4 digits)	—
H1B	Position command [before electronic gear] (upper 4 digits)	—
H1C	Current position [before electronic gear] (lower 4 digits)	—
H1D	Current position [before electronic gear] (upper 4 digits)	—
H1E	Droop pulse [after electronic gear] (lower 4 digits)	—
H1F	Droop pulse [after electronic gear] (upper 4 digits)	—
H24	Ideal speed command	r/min
H25	Speed command	r/min
H34	PID set point	0.1%
H35	PID measured value	0.1%
H36	PID deviation	0.1%
H3D	Motor thermal load factor	0.1%
H3E	Drive unit thermal load factor	0.1%
H3F	Cumulative power 2	0.01kWh

*1 When "0.01 to 9998" is set in *Pr.37* and "01" in instruction code HFF, the data format is 6 digits (E2).

*2 Input terminal monitor details (when the terminal is ON: 1, when the terminal is OFF: 0, —: undetermined value)

b15 ... b0

—	—	—	—	—	RES	—	MRS	—	RH	RM	RL	—	—	STR	STF

*3 Output terminal monitor details (when the terminal is ON: 1, when the terminal is OFF: 0, —: undetermined value)

b15 ... b0

—	—	—	—	—	—	—	—	—	—	ABC	FU	—	—	—	RUN

[Fault data]

Refer to page 267 for details of fault description

Data	Definition
H00	No fault present
H10	E.OC1
H11	E.OC2
H12	E.OC3
H20	E.OV1
H21	E.OV2
H22	E.OV3
H30	E.THT
H31	E.THM
H40	E.FIN
H52	E.ILF
H60	E.OLT

Data	Definition
H61	E.SOT
H70	E.BE
H80	E.GF
H81	E.LF
H90	E.OHT
HA0	E.OPT
HA1	E.OP1
HB0	E.PE
HB1	E.PUE
HB2	E.RET
HB3	E.PE2
HC0	E.CPU
HC5	E.IOH

Data	Definition
HC7	E.AIE
HC8	E.USB
HC9	E.SAF
HD0	E.OS
HD1	E.OSD
HD3	E.OD
HDD	E.OA
HF1	E.1
HF5	E.5
HF6	E.6
HF7	E.7
HFD	E.13

Fault record display example (instruction code H74)

For read data H3010
(Previous fault... THT)
(Latest fault... OC1)

b15							b8	b7							b0
0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0

Previous fault (H30) — Latest fault (HA1)

[Run command]

Item	Instruction Code	Bit Length	Description	Example
Run command ∗3	HFA	8 bits	b0: Current input selection (Fixed) b1: Forward rotation command (Fixed) b2: Reverse rotation command (Fixed) b3: RL (low speed operation command) ∗1 (Variable)) b4: RM (middle speed operation command ∗1 (Variable)) b5: RH (high speed operation command ∗1 (Variable)) b6: Second function selection (Fixed) b7: MRS (output stop ∗1 (Variable))	[Example 1] H02... Forward rotation b7 … b0 0 0 0 0 0 0 1 0 [Example 2] H00... Stop b7 … b0 0 0 0 0 0 0 0 0
Run command (expansion) ∗3	HF9	16 bits	b0: Current input selection (Fixed) b1: Forward rotation command (Fixed) b2: Reverse rotation command (Fixed) b3: RL (low speed operation command ∗1 (Variable)) b4: RM (middle speed operation command ∗1 (Variable)) b5: RH (high speed operation command ∗1 (Variable)) b6: Second function selection (Fixed) b7: MRS (output stop ∗1 (Variable)) b8: — b9: — b10: — b11: RES (Reset (Variable)) ∗1, ∗2 b12: — b13: — b14: — b15: —	[Example 1] H0002... Forward rotation b15 … b0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 [Example 2] H0800... Low speed operation (When *Pr. 184 RES terminal function selection* is set to "0") b15 … b0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

∗1 The signal is the default setting. The description changes depending on the setting of *Pr.180 to Pr.184 (input terminal function selection) (page 138)*.

∗2 The signal is the default setting. Reset cannot be controlled by the network, bit 11 is invalid in the initial status. When using bit 11, change the signal with *Pr.184 RES terminal function selection (page 138)* (Reset can be executed with the instruction code HFD)

∗3 When *Pr.551* = "2" (PU Mode command source is PU connector), only forward rotation and reverse rotation can be used.

[Drive unit status monitor]

Item	Instruction Code	Bit Length	Description	Example
Drive unit status monitor	H7A	8 bits	b0: RUN (Drive unit running * (Variable)) b1: During forward rotation (Fixed) b2: During reverse rotation (Fixed) b3: Up-to-speed (Fixed) b4: Overload (Fixed) b5: — b6: FU (speed detection * (Variable)) b7: ABC (fault * (Variable))	[Example 1] H02... During forward rotation b7 → b0: 0 0 0 0 0 0 1 0 [Example 2] H80... Stop at fault occurrence b7 → b0: 1 0 0 0 0 0 0 0
Drive unit status monitor (expansion)	H79	16 bits	b0: RUN (drive unit running * (Variable)) b1: During forward rotation (Fixed) b2: During reverse rotation (Fixed) b3: Up-to-speed (Fixed) b4: Overload (Fixed) b5: — b6: FU (speed detection * (Variable)) b7: ABC (fault * (Variable)) b8: — b9: — b10: — b11: — b12: — b13: — b14: — b15: Fault occurrence (Fixed)	[Example 1] H0002... During forward rotation b15 → b0: 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 [Example 2] H8080... Stop at fault occurrence b15 → b0: 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

* The signal within parentheses is the default setting. Definitions change according to the *Pr.190 to Pr.192 (output terminal function selection)*.

[Multi command (HF0)]

Sending data format from computer to drive unit

Format	Number of Characters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A3	ENQ	Drive unit station number		Instruction Code (HF0)		Waiting time	Send data type*1	Receive data type*2	Data1 *3				Data2 *3				Sum check		CR/LF

Reply data format from drive unit to computer (No data error detected)

Format	Number of Characters																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
C1	STX	Drive unit station number		Send data type *1	Receive data type *2	Error code 1 *5	Error code 2 *5	Data1 *4				Data2 *4				ETX	Sum check		CR/LF

*1 Specify the data type of sending data (from computer to drive unit). When specifying data type 4, set 4 for both the sending data and reply data.

*2 Specify the data type of reply data (from drive unit to computer). When specifying data type 4, set 4 for both the sending data and reply data.

*3 Combination of data 1 and data 2 for sending

Data Type	Data 1	Data 2	Remarks
0	Run command (expansion)	Set speed (RAM)	Run command (expansion) is same as instruction code HF9 *(Refer to page 219)* The unit of set speed (frequency) is always by four digits, even when "0.01 to 9998" is set in *Pr.37* and "01" is set in instruction code HFF.
1	Run command (expansion)	Set speed (RAM, EEPROM)	
4	H00 + monitor code 1	H00 + monitor code 2	Set a special monitor selection No. in monitor code 1 and 2. (Set 00 in the upper two digits.)

*4 Combination of data 1 and data 2 for reply

Data Type	Data 1	Data 2	Remarks
0	Drive unit status monitor (expansion)	Rotation speed (output frequency)	Drive unit status monitor (expansion) is same as instruction code H79 *(Refer to page 220)* The unit of speed (frequency) monitor is always by four digits (rounds down after the decimal point), even when "0.01 to 9998" is set in *Pr.37* and "01" is set in instruction code HFF. Replys the monitor item specified in instruction code HF3 for special monitor. *(Refer to page 218)*
1	Drive unit status monitor (expansion)	Special monitor	
4	First monitor value	Second monitor value	The first monitor value and second monitor value store the monitor data specified by the sending data type 4. When the sending data type is not 4, the first monitor value stores the current monitor and the second monitor value stores the rotation speed monitor. The unit of speed (frequency) monitor is always by four digits (rounds down after the decimal point), even when "0.01 to 9998" is set in *Pr.37* and "01" is set in instruction code HFF.

*5 Error code for sending data 1 is set in error code 1, and error code for sending data 2 is set in error code 2.
Mode error (HA), instruction code error (HB), data range error (HC) or no error (HF) is replied.

4.18.6 Modbus-RTU communication specifications (Pr.117, Pr.118, Pr.120, Pr.122, Pr.343, Pr.502, Pr.549)

Using the Modbus-RTU communication protocol, communication operation or parameter setting can be performed from the PU connector of the drive unit.

<table>
<tr><th>Parameter number</th><th>Name</th><th>Initial value</th><th>Setting range</th><th colspan="4">Description</th></tr>
<tr><td rowspan="2">117</td><td rowspan="2">PU communication station number</td><td rowspan="2">0</td><td>0</td><td colspan="4">No reply to the master *</td></tr>
<tr><td>1 to 247</td><td colspan="4">Drive unit station number specification
Set the drive unit station numbers when two or more drive units are connected to one personal computer.</td></tr>
<tr><td>118</td><td>PU communication speed</td><td>192</td><td>48, 96, 192, 384</td><td colspan="4">Communication speed
The setting value × 100 equals the communication speed.
Example) 9600bps if 96</td></tr>
<tr><td rowspan="3">120</td><td rowspan="3">PU communication parity check</td><td rowspan="3">2</td><td>0</td><td colspan="4">Without parity check
Stop bit length 2 bits</td></tr>
<tr><td>1</td><td colspan="4">With odd parity check
Stop bit length 1 bit</td></tr>
<tr><td>2</td><td colspan="4">With even parity check
Stop bit length 1 bit</td></tr>
<tr><td rowspan="3">122</td><td rowspan="3">PU communication check time interval</td><td rowspan="3">0</td><td>0</td><td colspan="4">RS-485 communication can be made. Note that a communication fault (E.PUE) occurs as soon as the drive unit is switched to the operation mode with command source.</td></tr>
<tr><td>0.1 to 999.8s</td><td colspan="4">Communication check (signal loss detection) time interval If a no-communication state persists for longer than the permissible time, the drive unit trips (depends on Pr.502).</td></tr>
<tr><td>9999</td><td colspan="4">No communication check (signal loss detection)</td></tr>
<tr><td>343</td><td>Communication error count</td><td>0</td><td>—</td><td colspan="4">Displays the number of communication errors during Modbus-RTU communication (reading only)</td></tr>
<tr><td rowspan="4">502</td><td rowspan="4">Stop mode selection at communication error</td><td rowspan="4">0</td><td></td><td>At Fault Occurrence</td><td>Indication</td><td>Fault Output</td><td>At Fault Removal</td></tr>
<tr><td>0, 3</td><td>Coasts to stop.</td><td>E.PUE</td><td>Output</td><td>Stop (E.PUE)</td></tr>
<tr><td>1</td><td>Decelerates to stop</td><td>After stop E.PUE</td><td>Output after stop</td><td>Stop (E.PUE)</td></tr>
<tr><td>2</td><td>Decelerates to stop</td><td>After stop E.PUE</td><td>Without output</td><td>Automatic restart functions</td></tr>
<tr><td rowspan="2">549</td><td rowspan="2">Protocol selection</td><td rowspan="2">0</td><td>0</td><td colspan="4">Mitsubishi inverter (computer link operation) protocol</td></tr>
<tr><td>1</td><td colspan="4">Modbus-RTU protocol</td></tr>
</table>

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

* When Modbus-RTU communication is performed from the master with address 0 (station number 0) set, broadcast communication is selected and the drive unit does not send a response message. When response from the drive unit is necessary, set a value other than "0" (initial value is 0) in *Pr.117 PU communication station number*.
Some functions are invalid for broadcast communication. *(Refer to page 225)*

NOTE

- **When "1" (Modbus-RTU protocol) is set in *Pr.549* and "384" (38400bps) in *Pr.118*, parameter unit (FR-PU07) is disabled. When using the parameter unit (FR-PU07), change parameter using the operation panel.**

REMARKS

- Set *Pr.549 Protocol selection* to "1" to use the Modbus-RTU protocol.
- When PU connector is selected as NET mode command source (when *Pr.550 NET mode operation command source selection* = "2" or "9999" (initial value) without communication option), Modbus-RTU communication operation can be performed. *(Refer to page 195)*

(1) Communication

- The communication specifications are given below.

Item		Description	Related Parameter
Communication protocol		Modbus-RTU protocol	Pr.549
Conforming standard		EIA-485 (RS-485)	—
Number of connectable devices		1: N (maximum 32 units), setting is 0 to 247 stations	Pr.117
Communication speed		Selected among 4800/9600/19200/38400bps	Pr.118
Control procedure		Asynchronous	—
Communication method		Half-duplex	—
Communication	Character system	Binary (always 8 bits)	—
	Start bit	1 bit	—
	Stop bit length	Select from the following three types •No parity, stop bit length 2 bits •No odd parity, stop bit length 1 bit •Even parity, stop bit length 1 bit	Pr.120
	Parity check		
	Error check	CRC code check	—
	Terminator	Not used	—
Waiting time setting		Not used	—

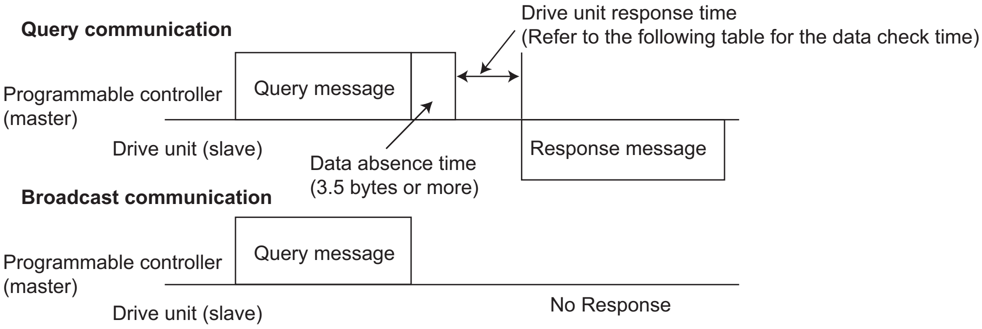
(2) Outline

The Modbus protocol is the communication protocol developed by Modicon for PLC.
The Modbus protocol performs serial communication between the master and slave using the dedicated message frame. The dedicated message frame has the functions that can perform data read and write. Using the functions, you can read and write the parameter values from the drive unit, write the input command of the drive unit, and check the operating status. In this product, the drive unit data are classified in the holding register area (register addresses 40001 to 49999). By accessing the assigned holding register address, the master can communicate with the drive unit which is a slave.

REMARKS

There are two different serial transmission modes: ASCII (American Standard Code for Information Interchange) mode and RTU (Remote Terminal Unit) mode. This product supports only the RTU mode in which 1-byte (8-bit) data is transmitted as-is.
Only the communication protocol is defined by the Modbus protocol, and the physical layer is not stipulated.

(3) Message format



●Data check time

Item	Check Time
Various monitors, operation command, speed setting (RAM)	< 20ms
Parameter read/write, speed setting (EEPROM)	< 50ms
Parameter clear/all clear	< 5s
Reset command	No answer

1) Query
The master sends a message to the slave (= drive unit) at the specified address.

2) Normal Response
After receiving the query from the master, the slave executes the requested function and returns the corresponding normal response to the master.

3) Error Response
If an invalid function code, address or data is received, the slave returns it to the master.
When a response description is returned, the error code indicating that the request from the master cannot be executed is added.
No response is returned for the hardware-detected error, frame error and CRC check error.

4) Broadcast
By specifying address 0, the master can send a message to all slaves. All slaves that received the message from the master execute the requested function. In this communication, the slaves do not return a response to the master.

REMARKS

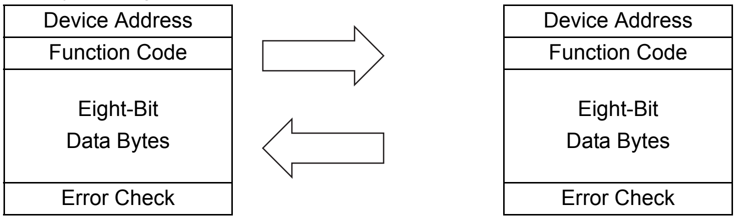
The drive unit performs the function independently of the drive unit station number setting *(Pr.117)* during broadcast communication.

(4) Message frame (protocol)

●Communication method

Basically, the master sends a query message (question) and the slave returns a response message (response). When communication is normal, Device Address and Function Code are copied as they are, and when communication is abnormal (function code or data code is illegal), bit 7 (= 80h) of Function Code is turned ON and the error code is set to Data Bytes.

Query message from Master



Response message from slave

The message frame consists of the four message fields as shown above.
By adding the no-data time (T1: Start, End) of 3.5 characters to the beginning and end of the message data, the slave recognizes it as one message.

●Protocol details

The four message fields will be explained below.

Start	1) ADDRESS	2) FUNCTION	3) DATA	4) CRC CHECK		End
				L	H	
T1	8 bits	8 bits	n×8 bits	8 bits	8 bits	T1

Message Field	Description
1)ADDRESS field	The address code is 1 byte long (8 bits) and any of 0 to 247 can be set. Set 0 to send a broadcast message (all-address instruction) or any of 1 to 247 to send a message to each slave. When the slave responds, it returns the address set from the master. The value set to *Pr.117 PU communication station number* is the slave address.
2)FUNCTION field	The function code is 1 byte long (8 bits) and any of 1 to 255 can be set. The master sets the function that it wants to request from the slave, and the slave performs the requested operation. The following table gives the supported function codes. An error response is returned if the set function code is other than those in the following table. When the slave returns a normal response, it returns the function code set by the master. When the slave returns an error response, it returns H80 + function code. (See Table 1 below.)
3)DATA field	The format changes depending on the function code *(Refer to page 226)*. Data includes the byte count, number of bytes, description of access to the holding register, etc.
4)CRC CHECK field	The received message frame is checked for error. CRC check is performed, and 2 byte long data is added to the end of the message. When CRC is added to the message, the low-order byte is added first and is followed by the high-order byte. The CRC value is calculated by the sending side that adds CRC to the message. The receiving side recalculates CRC during message receiving, and compares the result of that calculation and the actual value received in the CRC CHECK field. If these two values do not match, the result is defined as error.

Code	Function Name	Outline	Broadcast Communication
H03	Read Holding Register	Reads the holding register data.	Disallowed
H06	Preset Single Register	Writes data to the holding register.	Allowed
H08	Diagnostics	Function diagnosis (communication check only)	Disallowed
H10	Preset Multiple Registers	Writes data to multiple consecutive holding registers.	Allowed
H46	Read Holding Register Access Log	Reads the number of registers that succeeded in communication last time.	Disallowed

Table 1:Function code list

(5) Message format types

The message formats corresponding to the function codes in Table 1 on page 225 will be explained.

- **Read holding register data (H03 or 03)**

  Can read the description of **1)** system environment variables, **2)** real-time monitor, **3)** faults history, and **4)** drive unit parameters assigned to the holding register area (refer to the register list (page 231))

8 bitsNormal response (Response message)

1) Slave Address	2) Function	3) Starting Address		4) No. of Points		CRC Check	
(8 bits)	H03 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

1) Slave Address	2) Function	5) Byte Count	6) Data			CRC Check	
(8 bits)	H03 (8 bits)	(8 bits)	H (8 bits)	L (8 bits)	... (n×16 bits)	L (8 bits)	H (8 bits)

• Query message setting

Message	Setting Description
1) Slave Address	Address to which the message will be sent Broadcast communication cannot be made (0 is invalid).
2) Function	Set H03
3) Starting Address	Set the address at which holding register data read will be started. Starting Address = Starting register address (decimal)-40001 For example, setting of the Starting Address 0001 reads the data of the holding register 40002.
4) No. of Points	Number of holding registers from which data will be read The number of registers from which data can be read is a maximum of 125.

• Description of normal response

Message	Setting Description
5) Byte Count	The setting range is H02 to HFA (2 to 250). Twice greater than the No. of Point specified at **4)** is set.
6) Data: Read data	The number of data specified at **4)** is set. Data are read in order of Hi byte and Lo byte, and set in order of Starting Address data, Starting Address + 1 data, Starting Address + 2 data,

Example: To read the register values of 41004 *(Pr.4)* to 41006 *(Pr.6)* from the slave address 17 (H11)

Query message

Slave Address	Function	Starting Address		No. of Points		CRC Check	
H11 (8 bits)	H03 (8 bits)	H03 (8 bits)	HEB (8 bits)	H00 (8 bits)	H03 (8 bits)	H77 (8 bits)	H2B (8 bits)

Normal response (Response message)

Slave Address	Function	Byte Count	Data						CRC Check	
H11 (8 bits)	H03 (8 bits)	H06 (8 bits)	H17 (8 bits)	H70 (8 bits)	H0B (8 bits)	HB8 (8 bits)	H03 (8 bits)	HE8 (8 bits)	H2C (8 bits)	HE6 (8 bits)

Read value (for frequency setting)

Register 41004*(Pr.4)*: H1770 (60.00Hz)

Register 41005*(Pr.5)*: H0BB8 (30.00Hz)

- **Write holding register data (H06 or 06)**

Can write the description of **1)** system environment variables and **4)** drive unit parameters assigned to the holding register area (refer to the register list *(page 231)*).

Query message

1) Slave Address	2) Function	3) Register Address		4) Preset Data		CRC Check	
(8 bits)	H06 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

Normal response (Response message)

1) Slave Address	2) Function	3) Register Address		4) Preset Data		CRC Check	
(8 bits)	H06 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

• Query message setting

Message	Setting Description
1) Slave Address	Address to which the message will be sent Setting of address 0 enables broadcast communication
2) Function	Set H06
3) RegisterAddress	Address of the holding register to which data will be written Register address = Holding register address (decimal)-40001 For example, setting of register address 0001 writes data to the holding register address 40002.
4) Preset Data	Data that will be written to the holding register The written data is always 2 bytes.

• Description of normal response

1) to 4) (including CRC check) of the normal response are the same as those of the query message.
No response is made for broadcast communication.

Example: To write 60Hz (H1770) to 40014 (running speed RAM) at slave address 5 (H05). (for frequency setting)

Query message

Slave Address	Function	Register Address		Preset Data		CRC Check	
H05 (8 bits)	H06 (8 bits)	H00 (8 bits)	H0D (8 bits)	H17 (8 bits)	H70 (8 bits)	H17 (8 bits)	H99 (8 bits)

Normal response (Response message)
Same data as the query message

NOTE

For broadcast communication, no response is returned in reply to a query. Therefore, the next query must be made when the drive unit processing time has elapsed after the previous query.

- **Function diagnosis (H08 or 08)**

A communication check can be made since the query message sent is returned unchanged as a response message (function of sub function code H00).

Sub function code H00 (Return Query Data)

Query message

1) Slave Address	2) Function	3) Subfunction		4) Data		CRC Check	
(8 bits)	H08 (8 bits)	H00 (8 bits)	H00 (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

Normal response (Response message)

1) Slave Address	2) Function	3) Subfunction		4) Data		CRC Check	
(8 bits)	H08 (8 bits)	H00 (8 bits)	H00 (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

• Query message setting

Message	Setting Description
1) Slave Address	Address to which the message will be sent Broadcast communication cannot be made (0 is invalid).
2) Function	Set H08
3) Subfunction	Set H0000
4) Data	Any data can be set if it is 2 bytes long. The setting range is H0000 to HFFFF

• Description of normal response

1) to 4) (including CRC check) of the normal response are the same as those of the query message.

NOTE

For broadcast communication, no response is returned in reply to a query. Therefore, the next query must be made when the drive unit processing time has elapsed after the previous query.

- **Write multiple holding register data (H10 or 16)**

You can write data to multiple holding registers.

Query message

1) Slave Address	2) FTunction	3) Starting Address		4) No. of Registers		5) Byte Count	6) Data			CRC Check	
(8 bits)	H10 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	(8 bits)	H (8 bits)	L (8 bits)	... (n×2×8 bits)	L (8 bits)	H (8 bits)

Normal response (Response message)

1) Slave Address	2) Function	3) Starting Address		4) No. of Registers		CRC Check	
(8 bits)	H10 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

• Query message setting

Message	Setting Description
1) Slave Address	Address to which the message will be sent Setting of address 0 enables broadcast communication
2) Function	Set H10
3) Starting Address	Address where holding register data write will be started Starting address = Starting register address (decimal)-40001 For example, setting of the starting address 0001 reads the data of the holding register 40002.
4) No. of Points	Number of holding registers where data will be written The number of registers where data can be written is a maximum of 125.
5) Byte Count	The setting range is H02 to HFA (2 to 250). Set a value twice greater than the value specified at 4).
6) Data	Set the data specified by the number specified at 4). The written data are set in order of Hi byte and Lo byte, and arranged in order of the starting address data, starting address + 1 data, starting address + 2 data

• **Description of normal response**

1) to 4) (including CRC check) of the normal response are the same as those of the query message.

Example: To write 0.05s (H05) to 41007 *(Pr.7)* at the slave address 25 (H19) and 0.10s (H0A) to 41008 *(Pr.8)*.

Query message

Slave Address	Function	Starting Address		No. of Points		Byte Count	Data				CRC Check	
H19 (8 bits)	H10 (8 bits)	H03 (8 bits)	HEE (8 bits)	H00 (8 bits)	H02 (8 bits)	H04 (8 bits)	H00 (8 bits)	H05 (8 bits)	H00 (8 bits)	H0A (8 bits)	H86 (8 bits)	H3D (8 bits)

Normal response (Response message)

Slave Address	Function	Starting Address		No. of Points		CRC Check	
H19 (8 bits)	H10 (8 bits)	H03 (8 bits)	HEE (8 bits)	H00 (8 bits)	H02 (8 bits)	H22 (8 bits)	H61 (8 bits)

● Read holding register access log (H46 or 70)

A response can be made to a query made by the function code H03 or H10.

The starting address of the holding registers that succeeded in access during previous communication and the number of successful registers are returned.

In response to the query for other than the above function code, 0 is returned for the address and number of registers.

Query message

1) Slave Address	2) Function	CRC Check	
(8 bits)	H46 (8 bits)	L (8 bits)	H (8 bits)

Normal response (Response message)

1) Slave Address	2) Function	3) Starting Address		4) No. of Points		CRC Check	
(8 bits)	H46 (8 bits)	H (8 bits)	L (8 bits)	H (8 bits)	L (8 bits)	L (8 bits)	H (8 bits)

• **Query message setting**

Message	Setting Description
1) Slave Address	Address to which the message will be sent Broadcast communication cannot be made (0 is invalid).
2) Function	Set H46

• **Description of normal response**

Message	Setting Description
3) Starting Address	The starting address of the holding registers that succeeded in access is returned. Starting address = Starting register address (decimal)-40001 For example, when the starting address 0001 is returned, the address of the holding register that succeeded in access is 40002.
4) No. of Points	The number of holding registers that succeeded in access is returned.

Example: To read the successful register starting address and successful count from the slave address 25 (H19).

Query message

Slave Address	Function	CRC Check	
H19 (8 bits)	H46 (8 bits)	H8B (8 bits)	HD2 (8 bits)

Normal response (Response message)

Slave Address	Function	Starting Address		No. of Points		CRC Check	
H19 (8 bits)	H10 (8 bits)	H03 (8 bits)	HEE (8 bits)	H00 (8 bits)	H02 (8 bits)	H22 (8 bits)	H61 (8 bits)

Success of two registers at starting address 41007 *(Pr.7)* is returned.

4

PARAMETERS

- **Error response**

An error response is returned if the query message received from the master has an illegal function, address or data. No response is returned for a parity, CRC, overrun, framing or busy error.

NOTE

No response message is sent in the case of broadcast communication also.

Error response (Response message)

1) Slave Address	2) Function	3) Exception Code	CRC Check	
(8 bits)	H80 + Function (8 bits)	(8 bits)	L (8 bits)	H (8 bits)

Message	Setting Description
1) Slave Address	Address received from the master
2) Function	Master-requested function code + H80
3) Exception Code	Code in the following table

Error code list

Code	Error Item	Error Description
01	ILLEGAL FUNCTION	The set function code in the query message from the master cannot be handled by the slave.
02	ILLEGAL DATA ADDRESS *1	The set register address in the query message from the master cannot be handled by the drive unit. (No parameter, parameter read disabled, parameter write disabled)
03	ILLEGAL DATA VALUE	The set data in the query message from the master cannot be handled by the drive unit. (Out of parameter write range, mode specified, other error)

*1 An error will not occur in the following cases.
1)Function code H03 (Read holding register data)
When the No. of Points is 1 or more and there is one or more holding registers from which data can be read
2)Function code H10 (Write multiple holding register data)
When the No. of Points is 1 or more and there is 1 or more holding registers to which data can be written
Namely, when the function code H03 or H10 is used to access multiple holding registers, an error will not occur if a non-existing holding register or read disabled or write disabled holding register is accessed.

REMARKS

An error will occur if all accessed holding registers do not exist.
Data read from a non-existing holding register is 0, and data written there is invalid.

- **Message data mistake detection**

To detect the mistakes of message data from the master, they are checked for the following errors.
If an error is detected, a trip will not occur.

Error check item

Error Item	Error Description	Drive unit Operation
Parity error	The data received by the drive unit differs from the specified parity (*Pr.120* setting).	1) *Pr.343* is increased by 1 at error occurrence. 2) The terminal LF is output at error occurrence.
Framing error	The data received by the drive unit differs from the specified stop bit length (*Pr.120*).	
Overrun error	The following data was sent from the master before the drive unit completes data receiving.	
Message frame error	The message frame data length is checked, and the received data length of less than 4 bytes is regarded as an error.	
CRC check error	A mismatch found by CRC check between the message frame data and calculation result is regarded as an error.	

(6) Modbus registers

- System environment variable

Register	Definition	Read/write	Remarks
40002	Drive unit reset	Write	Any value can be written
40003	Parameter clear	Write	Set H965A as a written value.
40004	All Parameter clear	Write	Set H99AA as a written value.
40006	Parameter clear ∗1	Write	Set H5A96 as a written value.
40007	All parameter clear ∗1	Write	Set HAA99 as a written value.
40009	Drive unit status/control input instruction ∗2	Read/Write	See below.
40010	Operation mode/drive unit setting ∗3	Read/Write	See below.
40014	Running speed (RAM value)	Read/Write	According to the *Pr.37* settings, the frequency and selectable speed are in 1r/min increments.
40015	Running speed (EEPROM value)	Write	

∗1 The communication parameter values are not cleared.
∗2 For write, set the data as a control input instruction.
For read, data is read as a drive unit operating status.
∗3 For write, set data as the operation mode setting.
For read, data is read as the operation mode status.

<Drive unit status/control input instruction>

Bit	Definition	
	Control input instruction	Drive unit status
0	Stop command (Fixed)	RUN (Drive unit running ∗2 (Variable))
1	Forward rotation command (Fixed)	During forward rotation (Fixed)
2	Reverse rotation command (Fixed)	During reverse rotation (Fixed)
3	RH (high-speed operation command ∗1 (Variable))	Up-to-speed (Fixed)
4	RM (middle-speed operation command ∗1 (Variable))	Overload (Fixed)
5	RL (low-speed operation command ∗1 (Variable))	0
6	0	FU (speed detection) ∗2 (Variable))
7	Second function selection (Fixed)	ABC (fault ∗2 (Variable))
8	Current input selection (Fixed)	0
9	0	0
10	MRS (output stop ∗1 (Variable))	0
11	0	0
12	RES (reset ∗1 (Variable))	0
13	0	0
14	0	0
15	0	Fault occurrence (Fixed)

<Operation mode/drive unit setting>

Mode	Read Value	Written Value
EXT	H0000	H0010
PU	H0001	—
EXT JOG	H0002	—
PU JOG	H0003	—
NET	H0004	H0014
PU+EXT	H0005	—

The restrictions depending on the operation mode changes according to the computer link specifications.

∗1 The signal is the default setting. The description changes depending on the setting of *Pr.180 to Pr.184 (input terminal function selection). (Refer to page 138)*
Each assigned signal is valid or invalid depending on NET. *(Refer to page 195)*
∗2 The signal is the default setting. Definitions change according to the *Pr.190 to Pr.192 (output terminal function selection). (Refer to page 144)*

- Real time monitor

Refer to page 156 for details of the monitor description.

Register	Description	Unit
40201	Rotation speed/machine speed/output frequency *1	1/1/0.01Hz
40202	Output current	0.01A
40203	Output voltage	0.1V
40205	Rotation speed setting/machine speed setting/output frequency setting *1	1/1/0.01Hz
40208	Converter output voltage	0.1V
40209	Regenerative brake duty	0.1%
40210	Electronic thermal relay function load factor	0.1%
40211	Output current peak value	0.01A
40212	Converter output voltage peak value	0.1V
40214	Output power	0.01kW
40215	Input terminal status *2	—
40216	Output terminal status *3	—
40219	Position pulse	—
40220	Cumulative energization time	1h
40223	Actual operation time	1h
40224	Motor load factor	0.1%
40225	Cumulative power	1kWh

Register	Description	Unit
40226	Position command [before electronic gear] (lower 4 digits)	—
40227	Position command [before electronic gear] (upper 4 digits)	—
40228	Current position [before electronic gear] (lower 4 digits)	—
40229	Current position [before electronic gear] (upper 4 digits)	—
40230	Droop pulse [after electronic gear] (lower 4 digits)	—
40231	Droop pulse [after electronic gear] (upper 4 digits)	—
40236	Ideal speed command	r/min
40237	Speed command	r/min
40252	PID set point	0.1%
40253	PID measured value	0.1%
40254	PID deviation	0.1%
40261	Motor thermal load factor	0.1%
40262	Drive unit thermal load factor	0.1%
40263	Cumulative power 2	0.01kWh

*1 When *Pr.37* = "0.01 to 9998", displayed in integral number.

*2 Input terminal monitor details (when the terminal is ON: 1, when the terminal is OFF: 0, —: undetermined value)

b15 b0

—	—	—	—	—	RES	—	MRS	—	RH	RM	RL	—	—	STR	STF

*3 Output terminal monitor details (when the terminal is ON: 1, when the terminal is OFF: 0, —: undetermined value)

b15 b0

—	—	—	—	—	—	—	—	—	—	ABC	FU	—	—	—	RUN

- Parameter

Parameter	Register	Parameter Name	Read/ Write	Remarks
0 to 999	**41000 to 41999**	Refer to the parameter list *(page 52)* for the parameter names.	Read/ Write	The parameter number + 41000 is the register number.
C2(902)	**41902**	Terminal 2 speed setting bias speed	Read/ Write	
C3(902)	**42092**	Terminal 2 speed setting bias (Analog value)	Read/ Write	The analog value (%) set to *C3 (902)* is read.
	43902	Terminal 2 speed setting bias (Terminal analog value)	Read	The analog value (%) of the voltage applied to the terminal 2 is read.
125(903)	**41903**	Terminal 2 speed setting gain speed	Read/ Write	
C4(903)	**42093**	Terminal 2 speed setting gain (Analog value)	Read/ Write	The analog value (%) set to *C4 (903)* is read.
	43903	Terminal 2 speed setting gain (Terminal analog value)	Read	The analog value (%) of the voltage applied to the terminal 2 is read.
C5(904)	**41904**	Terminal 4 speed setting bias speed	Read/ Write	
C6(904)	**42094**	Terminal 4 speed setting bias (Analog value)	Read/ Write	The analog value (%) set to *C6 (904)* is read.
	43904	Terminal 4 speed setting bias (Terminal analog value)	Read	The analog value (%) of the current (voltage) applied to the terminal 4 is read.
126(905)	**41905**	Terminal 4 speed setting gain speed (Speed)	Read/ Write	
C7(905)	**42095**	Terminal 4 speed setting gain (Analog value)	Read/ Write	The analog value (%) set to *C7 (905)* is read.
	43905	Terminal 4 speed setting gain (Terminal analog value)	Read	The analog value (%) of the current (voltage) applied to the terminal 4 is read.

- Faults history

Register	Definition	Read/Write	Remarks
40501	Fault history 1	Read/Write	Being 2 bytes in length, the data is stored as "H00○○". Refer to the lowest 1 byte for the error code. Performing write using the register 40501 batch-clears the faults history. Set any value as data.
40502	Fault history 2	Read	
40503	Fault history 3	Read	
40504	Fault history 4	Read	
40505	Fault history 5	Read	
40506	Fault history 6	Read	
40507	Fault history 7	Read	
40508	Fault history 8	Read	

Fault code list

Data	Definition	Data	Definition	Data	Definition	Data	Definition
H00	No fault present	H40	E.FIN	HB0	E.PE	HD1	E.OSD
H10	E.OC1	H52	E.ILF	HB1	E.PUE	HD3	E.OD
H11	E.OC2	H60	E.OLT	HB2	E.RET	HDD	E.OA
H12	E.OC3	H61	E.SOT	HB3	E.PE2	HF1	E.1
H20	E.OV1	H70	E.BE	HC0	E.CPU	HF5	E.5
H21	E.OV2	H80	E.GF	HC5	E.IOH	HF6	E.6
H22	E.OV3	H81	E.LF	HC7	E.AIE	HF7	E.7
H30	E.THT	H90	E.OHT	HC8	E.USB	HFD	E.13
H31	E.THM	HA0	E.OPT	HC9	E.SAF		
		HA1	E.OP1	HD0	E.OS		

* *Refer to page 267* for details of fault description.

- Model information monitor

Register	Definition	Read/Write	Remarks
44001 to 44010	Drive unit model	Read	Reading drive unit model in ASCII code. "H20" (blank code) is set for blank area Example of FR-E720EX H46, H52, H2D, H45, H37, H32, H30, H45, H58, H20 ......H20
44011 to 44013	Capacity	Read	Reading drive unit capacity in ASCII code. Data is read in increments of 0.1kW, and rounds down to 0.01kW increments "H20" (blank code) is set for blank area Example 0.75K................" 7" (H20, H20, H20, H20, H20, H37)

(7) *Pr.343 Communication error count*

You can check the cumulative number of communication errors.

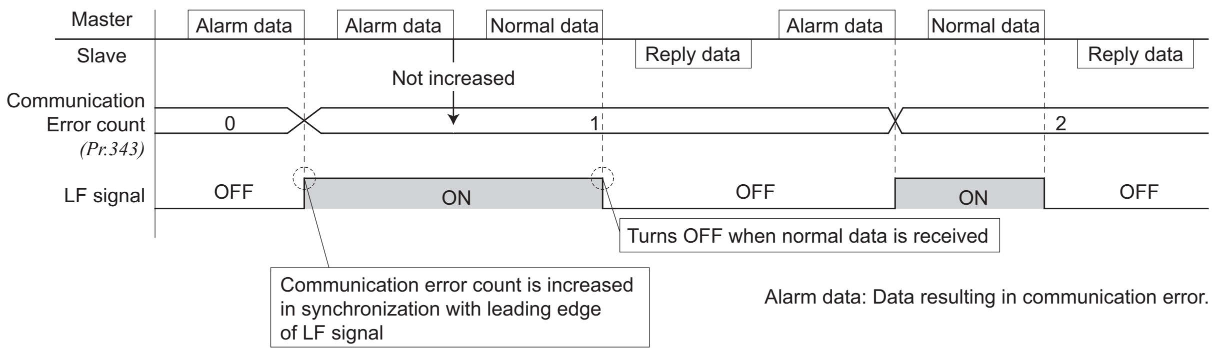
Parameter	Setting Range	Minimum Setting Range	Initial Value
343	(Reading only)	1	0

NOTE

The number of communication errors is temporarily stored into the RAM. As it is not stored into the EEPROM performing a power supply reset or drive unit reset clears the value to 0.

(8) Output terminal LF "alarm output (communication error warnings)"

During a communication error, the alarm signal (LF signal) is output by open collector output. Assign the used terminal using any of *Pr.190 to Pr.192 (output terminal function selection)*.



NOTE

The LF signal can be assigned to the output terminal using any of *Pr.190 to Pr.192*. Changing the terminal assignment may affect the other functions. Set parameters after confirming the function of each terminal.

4.18.7 USB communication (Pr. 547, Pr. 548)

Drive unit setup can be easily performed using the FR Configurator by connecting the drive unit and personal computer with a USB cable.

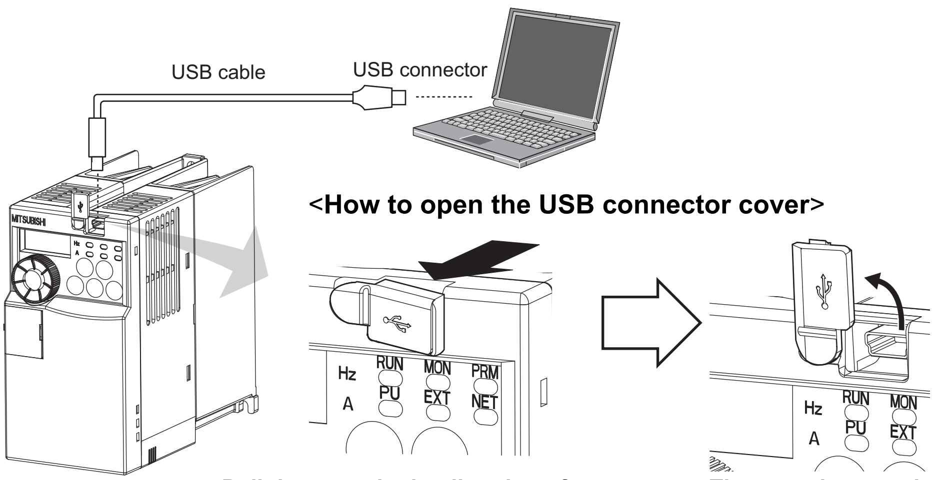
- A personal computer and drive unit can be easily connected with one USB cable.

Parameter number	Name	Initial value	Setting range	Description
547*	**USB communication station number**	0	0 to 31	Drive unit station number specification
548*	**USB communication check time interval**	9999	0	USB communication is possible Trips in the PU operation mode (E.USB)
			0.1 to 999.8s	Sets the interval of communication check time. If a no-communication state persists for longer than the permissible time, the drive unit trips (E.USB).
			9999	No communication check

* Changed setting value is valid when powering on or resetting the drive unit.

●USB communication specifications

Interface	Conforms to USB1.1
Transmission speed	12Mbps
Wiring length	Maximum 5m
Connector	USB mini B connector (receptacle mini B type)
Power supply	Self-power supply

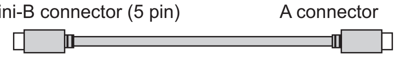


Pull the cover in the direction of arrow. **Then turn it upward.**

- You can perform parameter setting and monitoring with the FR Configurator. Refer to the instruction manual of the FR Configurator for details.

REMARKS

- USB cable available on the market

Name	Model	Application/Specifications
USB cable	MR-J3USBCBL3M Cable length 3m	Connector for amplifier mini-B connector (5 pin) — Connector for personal computer A connector 

Parameters referred to

Pr. 551 PU mode operation command source selection ☞ *Refer to page 195*

4.19 Special operation and speed control

Purpose	Parameter to set		Refer to page
To perform process control such as pump and air volume	**PID control**	**Pr.127 to Pr.134**	*235*
To avoid overvoltage alarm due to regeneration by automatic adjustment of output speed	**Regeneration avoidance function**	**Pr.882, Pr.883, Pr.885, Pr.886**	*242*

4.19.1 PID control (Speed control) (Pr.127 to Pr.134)

The drive unit can be used to exercise process control, e.g. flow rate, air volume or pressure.
The terminal 2 input signal or parameter setting is used as a set point and the terminal 4 input signal used as a feedback value to constitute a feedback system for PID control.

Parameter number	Name	Initial value	Setting range	Description	
127	**PID control automatic switchover speed**	9999	0 to 4800r/min *2	Speed at which the control is automatically changed to PID control.	
			9999	Without PID automatic switchover function	
128	**PID action selection**	0	0	PID action is not performed	
			20	PID reverse action	Measured value (terminal 4) Set value (terminal 2 or *Pr.133*)
			21	PID forward action	
			50	PID reverse action	Deviation value signal input (CC-Link communication)
			51	PID forward action	
			60	PID reverse action	Measured value, set point input (CC-Link communication)
			61	PID forward action	
129 *1	**PID proportional band**	100%	0.1 to 1000%	If the proportional band is narrow (parameter setting is small), the manipulated variable varies greatly with a slight change of the measured value. Hence, as the proportional band narrows, the response sensitivity (gain) improves but the stability deteriorates, e.g. hunting occurs. Gain Kp= 1/ proportional band	
			9999	No proportional control	
130 *1	**PID integral time**	1s	0.1 to 3600s	When deviation step is input, time (Ti) is the time required for integral (I) action to provide the same manipulated variable as the proportional (P) action. As the integral time decreases, the set point is reached earlier but hunting occurs more easily.	
			9999	No integral control.	
131	**PID upper limit**	9999	0 to 100%	Maximum value If the feedback value exceeds the setting, the FUP signal is output. The maximum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.	
			9999	No function	
132	**PID lower limit**	9999	0 to 100%	Minimum frequency If the measured value falls below the setting range, the FDN signal is output. The maximum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.	
			9999	No function	
133 *1	**PID action set point**	9999	0 to 100%	Used to set the set point for PID control.	
			9999	Terminal 2 input is the set point.	
134 *1	**PID differential time**	9999	0 to 100%	For deviation ramp input, time (Td) required for providing only the manipulated variable for the proportional (P) action. As the differential time increases, greater response is made to a deviation change.	
			9999	No differential control.	

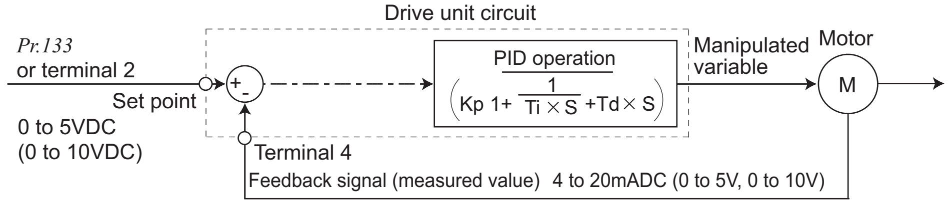
The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 *Pr.129, Pr.130, Pr.133 and Pr.134* can be set during operation. These can also be set independently of the operation mode.

*2 When a value exceeding 3000 r/min is set, the rotation speed will be limited at 3000 r/min.
Also, when an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 12000 r/min, 3.7K: 8000 r/min)

(1) PID control basic configuration

- *Pr.128* = "20, 21" (measured value input)



Kp: Proportionality constant Ti: Integral time S: Operator Td: Differential time

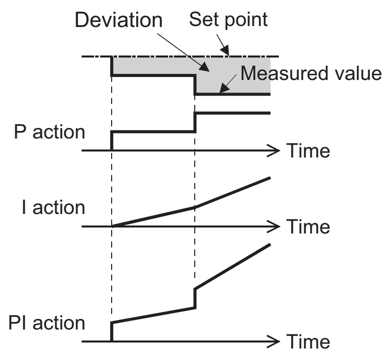
(2) PID action overview

1) PI action

A combination of proportional control action (P) and integral control action (I) for providing a manipulated variable in response to deviation and changes with time.

[Operation example for stepped changes of measured value]

(Note) PI action is the sum of P and I actions.

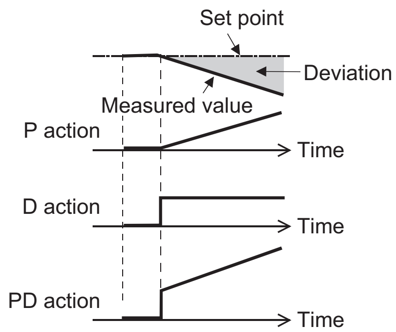


2) PD action

A combination of proportional control action (P) and differential control action (D) for providing a manipulated variable in response to deviation speed to improve the transient characteristic.

[Operation example for proportional changes of measured value]

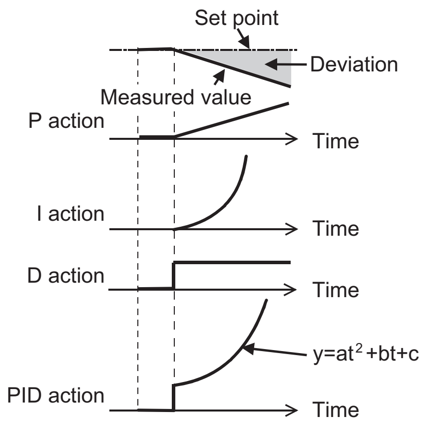
(Note) PD action is the sum of P and D actions.



3) PID action

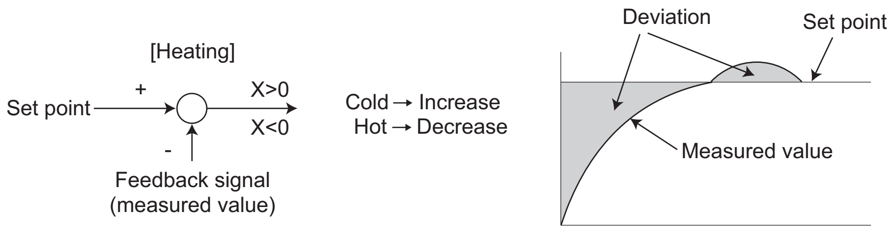
The PI action and PD action are combined to utilize the advantages of both actions for control.

(Note) PID action is the sum of P, I and D actions.



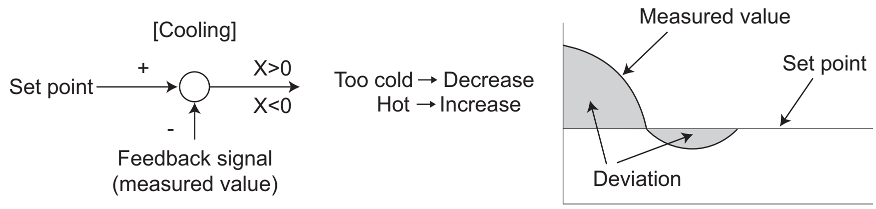
4) Reverse operation

Increases the manipulated variable (rotation speed) if deviation X = (set point - measured value) is positive, and decreases the manipulated variable if deviation is negative.



5) Forward operation

Increases the manipulated variable (rotation speed) if deviation X = (set point - measured value) is negative, and decreases the manipulated variable if deviation is positive.

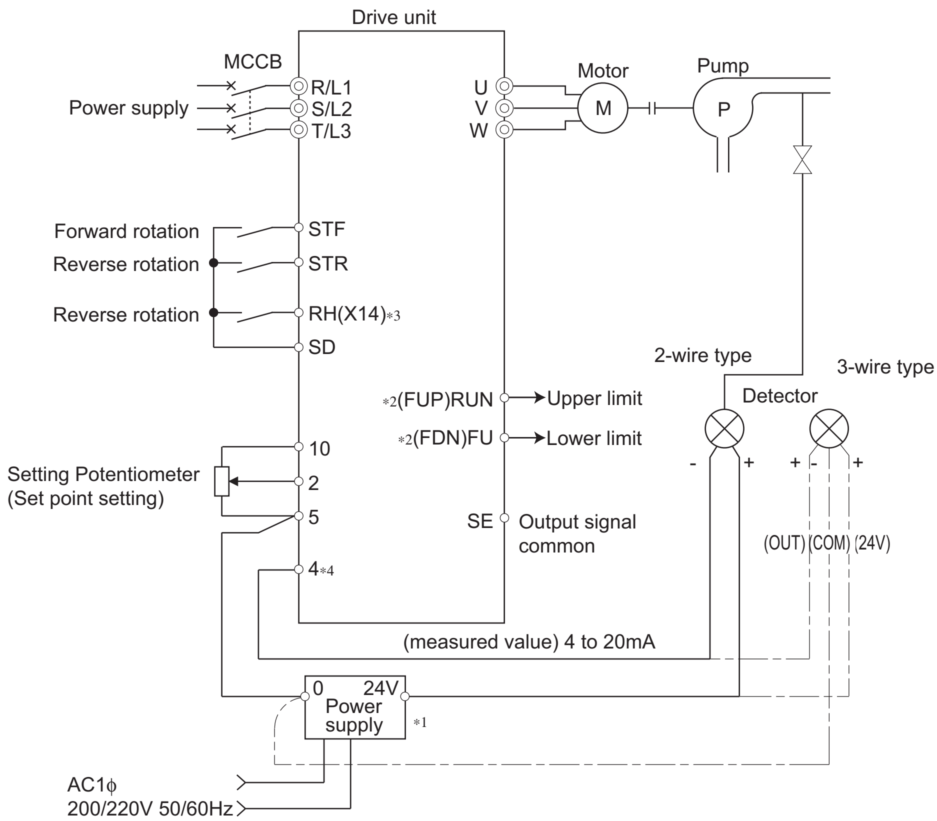


Relationships between deviation and manipulated variable (rotation speed)

	Deviation	
	Positive	Negative
Reverse action	↗	↘
Forward action	↘	↗

(3) Connection diagram

- Sink logic
- *Pr.128* = 20
- *Pr.182* = 14
- *Pr.190* = 15
- *Pr.191* = 14
- *Pr.192* = 16



*1 The power supply must be selected in accordance with the power specifications of the detector used.

*2 The used output signal terminal changes depending on the *Pr.190 to Pr.192 (output terminal selection)* setting.

*3 The used input signal terminal changes depending on the *Pr.178 to Pr.184 (input terminal selection)* setting.

*4 The AU signal need not be input.

(4) I/O signals and parameter setting

- Set "20, 21, 50, 51, 60 or 61" in *Pr.128* to perform PID operation.
- Set "14" in any of *Pr.178 to Pr.184 (input terminal function selection)* to assign PID control selection signal (X14) to turn the X14 signal ON.
  When the X14 signal is not assigned, only the *Pr.128* setting makes PID control valid.
- Enter the set point using the drive unit terminal 2 or *Pr.133* and enter the measured value to terminal 4.

REMARKS

- When *Pr.128* = "0" or X14 signal is OFF, normal drive unit operation is performed without PID action.
- Turning ON/OFF of bit of the terminal, to which X14 signal is assigned through network as RS-485 communication, enables PID control.

	Signal	Terminal Used	Function	Description	Parameter Setting
Input	X14	Depending on *Pr.178 to Pr.184*	PID control selection	Turn ON X14 signal to perform PID control. *1	Set 14 in any of *Pr.178 to Pr.184*.
	2	2	Set point input	You can input the set point for PID control.	*Pr.128* = 20, 21, *Pr.133* = 9999
				0 to 5V............ 0 to 100%	*Pr.73* = 1 *2, 11
				0 to 10V.......... 0 to 100%	*Pr.73* = 0, 10
	PU	—	Set point input	Set the set point *(Pr.133)* from the operation panel.	*Pr.128* = 20, 21, *Pr.133* = 0 to 100%
	4	4	Measured value input	Input the signal from the detector (measured value signal).	*Pr.128* = 20, 21
				4 to 20mA........ 0 to 100%	*Pr.267* = 0 *2
				0 to 5V............ 0 to 100%	*Pr.267* = 1
				0 to 10V.......... 0 to 100%	*Pr.267* = 2
	Communication *3	—	Deviation value input	Inputs the deviation value from CC-Link communication.	*Pr.128* = 50, 51
			Set point, measured value input	Inputs the set point and deviation value from CC-Link communication.	*Pr.128* = 60, 61
Output	FUP	Depending on *Pr.190 to Pr.192*	Upper limit output	Output to indicate that the measured value signal exceeded the maximum value *(Pr.131)*.	*Pr.128* = 20, 21, 60, 61 *Pr.131* ≠ 9999 Set 15 or 115 in any of *Pr.190 to Pr.192* *4
	FDN		Lower limit output	Output when the measured value signal falls below the minimum value *(Pr.132)*.	*Pr.128* = 20, 21, 60, 61 *Pr.132* ≠ 9999 Set 14 or 114 in any of *Pr.190 to Pr.192*. *4
	RL		Forward (reverse) rotation direction output	"Hi" is output to indicate that the output indication of the parameter unit is forward rotation (FWD) or "Low" to indicate that it is reverse rotation (REV) or stop (STOP).	Set 16 or 116 in any of *Pr.190 to Pr.192*. *4
	PID		During PID control activated	Turns ON during PID control.	Set 47 or 147 in any of *Pr.190 to Pr.192*. *4
	SE	SE	Output terminal common	Common terminal for open collector output terminal.	

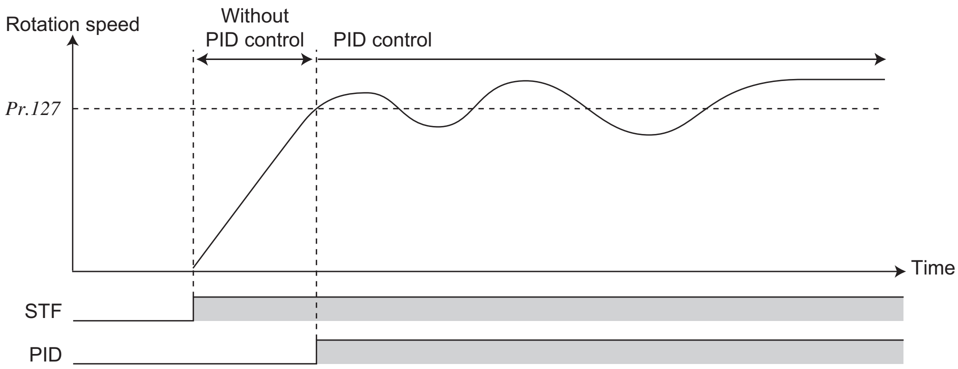
*1 When the X14 signal is not assigned, only the *Pr.128* setting makes PID control valid.
*2 The shaded area indicates the parameter initial value.
*3 Refer to the CC-Link communication option (FR-A7NC E kit) instruction manual for the setting method from CC-Link communication.
*4 When 100 or larger value is set in any of *Pr.190 to Pr.192 (output terminal function selection)*, the terminal output has negative logic. *(For details refer to page 144)*

NOTE

- **Changing the terminal function using any of *Pr.178 to Pr.184 and Pr.190 to Pr.192* may affect the other functions. Set parameters after confirming the function of each terminal.**
- **When the *Pr.267* setting was changed, check the voltage/current input switch setting. Different setting may cause a fault, failure or malfunction. (*Refer to page 168* for setting)**

(5) PID automatic switchover control *(Pr.127)*

- The system can be started up without PID control only at a start.
- When the speed is set to *Pr.127 PID control automatic switchover speed*, the drive unit starts up without PID control from a start until rotation speed is reached to the set speed of *Pr.127*, and then it shifts to PID control. Once the system has entered PID control operation, it continues PID control even if the rotation speed falls to or below *Pr.127*.



(6) PID monitor function

- The PID control set point, measured value and deviation value can be displayed on the operation panel and output from terminal FM.
- Integral value indicating a negative % can be displayed on the deviation monitor. 0% is displayed as 1000. (The deviation monitor cannot be output from the terminal FM.)
- For each monitor, set the following value in *Pr.52 DU/PU main display data selection* and *Pr.54 FM terminal function selection*.

Setting	Monitor Description	Minimum Increments	Terminal FM Full Scale	Remarks
52	**PID set point**	0.1%	100%	—
53	**PID measured value**	0.1%	100%	
54	**PID deviation**	0.1%	—	Value cannot be set to *Pr.54*. Displays 1000 when the PID deviation is 0%.

4

PARAMETERS

(7) Adjustment procedure

Parameter setting	Adjust the PID control parameters, *Pr.127 to Pr.134*.
Terminal setting	Set the I/O terminals for PID control *(Pr.178 to Pr.184 (input terminal function selection)*, *Pr.190 to Pr.192 (output terminal function selection))*
Turn ON the X14 signal.	When X14 signal is not assigned, setting a value other than "0" in *Pr.128* activates PID operation.
Operation	

(8) Calibration example

(A detector of 4mA at 0°C and 20mA at 50°C is used to adjust the room temperature to 25°C under PID control.
The set point is given to across drive unit terminals 2-5 (0 to 5V).)

Start

Determination of set point
Determine the set point of what is desired to be adjusted.
…… Set the room temperature to 25℃.
Set *Pr.128* and turn ON the X14 signal to enable PID control.

Conversion of set point into %
Calculate the ratio of the set point to the detector output.
…… Detector specifications
When 0℃→4mA and 50℃→20mA are used, the set point 25℃ is 50% on the assumption that 4mA is 0% and 20mA is 100%.

Make calibration.
…… Make the following calibration* when the target setting input (0 to 5V) and etector output (4 to 20mA) must be calibrated.

Setting of set point
Input a voltage across terminals 2-5 according to the set value %.
…… When the set point is 50%
As the terminal 2 specifications are 0% → 0V and 100% → 5V, input 2.5V to the terminal 2 for the set point of 50%.

Operation
Set the proportional band *(Pr.129)* to a slightly larger value, the integral time *(Pr.130)* to a slightly longer time, and the differential time *(Pr.134)* to "9999" (no function), and turn ON the start signal.
…… When the parameter unit is used for operation, input the set point (0 to 100%) in *Pr.133*.
When performing operation, first set the proportional band *(Pr.129)* to a slightly larger value, the integral time *(Pr.130)* to a slightly longer time, and the differential time *(Pr.134)* to "9999" (no function), and while looking at the system operation, decrease the proportional band *(Pr.129)* and increase the integral time *(Pr.130)*. For slow response system where a deadband exists, differential control *(Pr.134)* should be turned ON and increased slowly.

Is the set point stable?

Yes → **Parameter optimization**
While the measured value is stable throughout the operation status, the proportional band *(Pr.129)* may be decreased, the integral time *(Pr.130)* decreased, and the differential time *(Pr.134)* increased.

No → **Parameter adjustment**
To stabilize the measured value, change the proportional band *(Pr.129)* to a larger value, the integral time *(Pr. 130)* to a slightly longer time, and the differential time *(Pr.134)* to a slightly shorter time.

Adjustment end

*When calibration is required → Using calibration *Pr.902* and *Pr.903* (terminal 2) or *Pr.904* and *Pr.905* (terminal 4), calibrate the detector output and target setting input.
Make calibration in the PU mode during an drive unit stop.

<Set point input calibration>

1. Apply the input voltage of 0% set point setting (e.g. 0V) across terminals 2-5.
2. Enter in *C2 (Pr.902)* the speed which should be output by the drive unit at the deviation of 0% (e.g. 0r/min).
3. In *C3 (Pr.902)*, set the voltage value at 0%.
4. Apply the voltage of 100% set point (e.g. 5V) across terminals 2-5.
5. Enter in Pr.125 the speed which should be output by the drive unit at the deviation of 100% (e.g. 3000r/min).
6. In *C4 (Pr.903)*, set the voltage value at 100%.

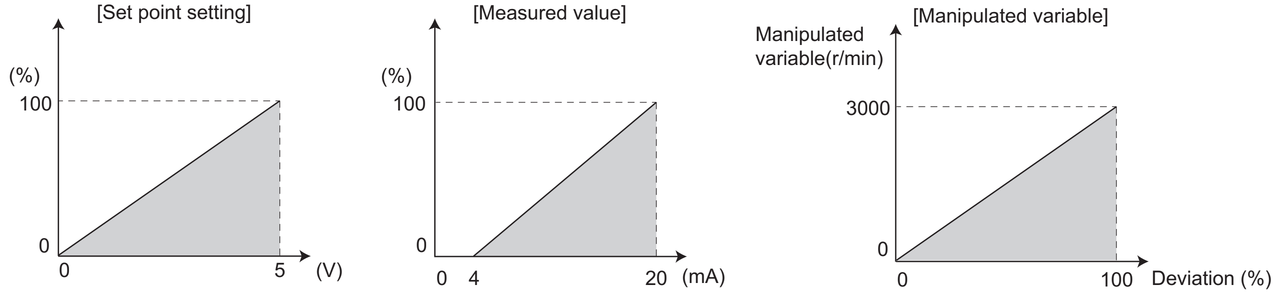
<Measured value calibration>

1. Apply the input current of 0% measured value (e.g. 4mA) across terminals 4-5.
2. Make calibration using *C6 (Pr.904)*.
3. Apply the input current of 100% measured value (e.g. 20mA) across terminals 4-5.
4. Make calibration using *C7 (Pr.905)*.

REMARKS

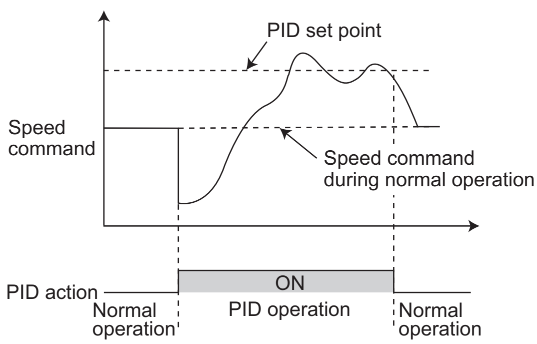
- The speed set in *C5 (Pr.904)* and *Pr.126* should be the same as set in *C2 (Pr.902)* and *Pr.125*.

The results of the above calibration are as shown below:



NOTE

- **Under position control, PID control is invalid.**
- **If the RH, RM, RL signal (multi-speed) or JOG signal (Jog operation2) (Jog operation) is entered with the X14 signal ON, PID control is stopped and multi-speed or Jog operation started.**
- **When *Pr.79 Operation mode selection* ="6" (switchover mode), PID control is invalid.**
- **Changing the terminal function using any of *Pr.178 to Pr.184*, *Pr.190 to Pr.192* may affect the other functions. Set parameters after confirming the function of each terminal.**
- **When PID control is selected, the minimum speed is the speed set in *Pr.902* and the maximum speed is the speed set in *Pr.903*.**
  (*Pr.1 Maximum setting* and *Pr.2 Minimum setting* are also valid.)
- **The remote operation function is invalid during PID operation.**
- **When the control is switched to PID control during normal operation, the speed command value calculated by PID operation using 0r/min as standard is used without the speed during the operation.**



Operation when control is switched to PID control during normal operation

Parameters referred to

Pr.59 Remote function selection *Refer to page 122*

Pr.73 Analog input selection *Refer to page 168*

Pr.79 Operation mode selection *Refer to page 186*

Pr.178 to Pr.184 (input terminal function selection) *Refer to page 138*

Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

C2(Pr.902) to C7(Pr.905) Speed setting voltage (current) bias/gain *Refer to page 173*

4.19.2 Regeneration avoidance function (Pr.665, Pr.882, Pr.883, Pr.885, Pr.886)

This function detects a regeneration status and increases the speed to avoid the regenerative status.

- Possible to avoid regeneration by automatically increasing the speed and continue operation if the fan happens to rotate faster than the set speed due to the effect of another fan in the same duct.

Parameter number	Name	Initial value	Setting range	Description
882	**Regeneration avoidance operation selection**	0	0	Regeneration avoidance function invalid
			1	Regeneration avoidance function is always valid
			2	Regeneration avoidance function is valid only during a constant speed operation
883	**Regeneration avoidance operation level**	400VDC	300 to 800V	Bus voltage level at which regeneration avoidance operates. When he bus voltage level is set to low, overvoltage error will be less apt to occur. However, the actual deceleration time increases. The set value must be higher than the "power supply voltage × $\sqrt{2}$
885	**Regeneration avoidance compensation speed limit value**	180r/min	0 to 540r/min *1	Limit value of speed which rises at activation of regeneration avoidance function.
			9999	Speed limit invalid
886	**Regeneration avoidance voltage gain**	100%	0 to 200%	Responsiveness at activation of regeneration avoidance. A larger setting will improve responsiveness to the bus voltage change. However, the rotation speed could become unstable. When vibration is not suppressed by decreasing the *Pr.886* setting, *Pr.665* set a smaller value in *Pr.665*.
665	**Regeneration avoidance speed gain**	100%	0 to 200%	

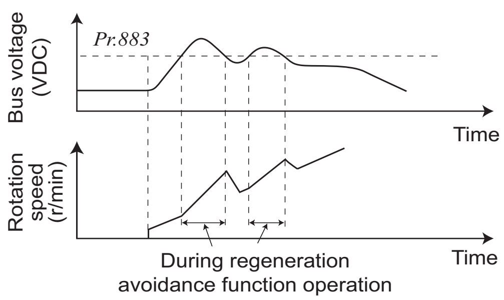
The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

*1 When an S-PM geared motor is used, the maximum setting value differs depending on the drive unit capacity. (0.2 to 2.2K: 1350 r/min, 3.7K: 900 r/min)

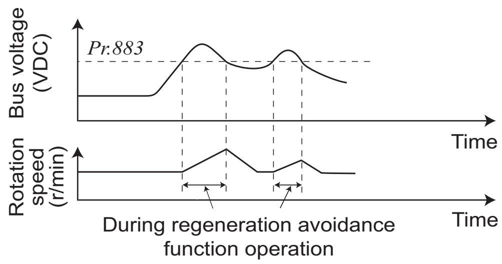
(1) What is regeneration avoidance function? *(Pr.882, Pr.883)*

- When the regeneration load is large, the DC bus voltage rises and an overvoltage fault (E. OV□) may occur. When this bus voltage rise is detected and the bus voltage level reaches or exceeds *Pr.883*, increasing the speed avoids the regeneration status.
- The regeneration avoidance function is always ON when "1" is set in *Pr.882* and activated only during a constant speed when "2" is set in *Pr.882*.

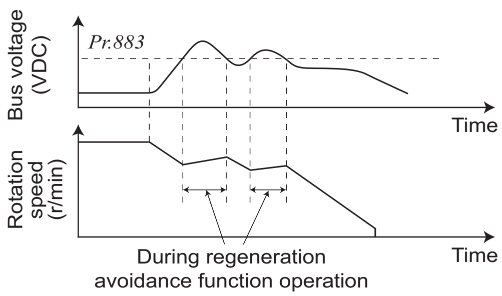
Regeneration avoidance operation example for acceleration



Regeneration avoidance operation example for constant speed

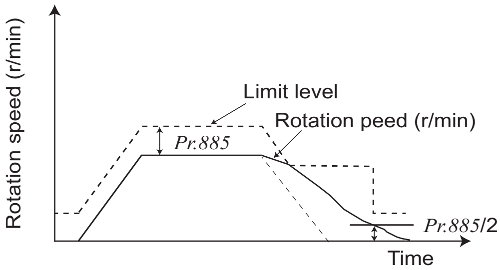


Regeneration avoidance operation example for deceleration



REMARKS

- The acceleration/deceleration ramp while the regeneration avoidance function is operating changes depending on the regeneration load.
- The DC bus voltage of the drive unit is about $\sqrt{2}$ times as input voltage.
  When the input voltage is 220VAC, bus voltage is approximately 311VDC.
  However, it varies with the input power supply waveform.
- The *Pr.883* setting should be kept higher than the DC bus voltage level. Otherwise, the regeneration avoidance function is always on even in the non-regeneration status and the speed increases.
- While overvoltage stall (oL) is activated only during deceleration and stops the rotation speed, the regeneration avoidance function is always on (*Pr.882* = 1) or activated only during a constant speed (*Pr.882* = 2) and increases the speed according to the regeneration amount.



(2) Limit regeneration avoidance operation speed *(Pr.885)*

You can limit the rotation speed compensated for (increased) by the regeneration avoidance function.

- The speed is limited to the rotation speed (speed prior to regeneration avoidance operation) + *Pr.885 Regeneration avoidance compensation speed limit value* during acceleration or constant speed.
  If the speed increased by regeneration avoidance function exceeds the limit value during deceleration, the limit value is held until the rotation speed falls to 1/2 of *Pr.885*.
- When the speed increased by regeneration avoidance function has reached *Pr.1 Maximum setting*, it is limited to the maximum speed.
- When *Pr.885* is set to "9999", regeneration avoidance function operation speed setting is invalid.

(3) Regeneration avoidance function adjustment *(Pr.665, Pr.886)*

- If the speed becomes instable during regeneration avoidance operation, decrease the setting of *Pr.886 Regeneration avoidance voltage gain*. Reversely, if sudden regeneration causes an overvoltage alarm, increase the setting.
  When vibration is not suppressed by decreasing the *Pr.886* setting, set a smaller value in *Pr.665 Regeneration avoidance speed gain*.

NOTE

- **When regeneration avoidance operation is performed, oL (overvoltage stall) is displayed and the OL signal is output. Set the operation pattern at an OL signal output using *Pr.156 Torque limit selection*. Set the output timing of the OL signal using *Pr.157 OL signal output timer*.**
- **When regeneration avoidance operation is performed, torque limit is also activated.**
- **The regeneration avoidance function cannot shorten the actual deceleration time taken to stop the motor. The actual deceleration time depends on the regeneration energy consumption capability. When shortening the deceleration time, consider using the regeneration unit (FR-BU2, FR-CV, FR-HC2) and brake resistor (MRS type and FRABR etc.,) to consume regeneration energy at constant speed.**
- **When using the regeneration unit (FR-BU2, FR-CV, FR-HC2) and brake resistor (MRS type and FR-ABR etc.,), set *Pr.882* to "0 (initial value)" (regeneration avoidance function invalid). When using the regeneration unit, etc. to consume regeneration energy at deceleration, set *Pr.882* to "2" (regeneration avoidance function valid only at a constant speed).**
- **Under position control, regeneration avoidance function is disabled.**

Parameters referred to

Pr.1 Maximum setting ☞ *Refer to page 115*
Pr.8 Deceleration time ☞ *Refer to page 125*
Pr.22 Torque limit level ☞ *Refer to page 111*

4.20 Useful functions

Purpose	Parameter to set		Refer to page
To increase the cooling fan life	Cooling fan operation selection	Pr. 244	244
To determine the maintenance time of parts	Drive unit part life display	Pr.255 to Pr.259	245
	Maintenance output function	Pr.503, Pr.504	248
	Current average value monitor signal	Pr.555 to Pr.557	249
To set freely available parameter	Free parameter	Pr.888, Pr.889	251
To initiate a fault alarm	Fault initiation	Pr.997	252

4.20.1 Cooling fan operation selection (Pr. 244)

You can control the operation of the cooling fan (1.5K or higher) built in the drive unit.

Parameter number	Name	Initial value	Setting range	Description
244	Cooling fan operation selection	1	0	Operates in power-ON status. Cooling fan ON/OFF control invalid (the cooling fan is always ON at power ON)
			1	Cooling fan ON/OFF control valid. The fan is always ON while the drive unit is running. During a stop, the drive unit status is monitored and the fan switches ON-OFF according to the temperature.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

- In either of the following cases, fan operation is regarded as faulty, [FN] is shown on the operation panel, and the fan fault (FAN) and alarm (LF) signals are output.
  - *Pr. 244* = "0"
    When the fan comes to a stop with power ON.
  - *Pr. 244* = "1"
    When the drive unit is running and the fan stops during fan ON command.
- For the terminal used for FAN signal output, set "25 (positive logic) or 125 (negative logic)" to any of *Pr. 190 to Pr. 192 (output terminal function selection)*, and for the LF signal, set "98 (positive logic) or 198 (negative logic)".

NOTE

- **Changing the terminal assignment using *Pr. 190 to Pr. 192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

4.20.2 Display of the life of the drive unit parts (Pr.255 to Pr.259)

Degrees of deterioration of main circuit capacitor, control circuit capacitor, cooling fan and inrush current limit circuit can be diagnosed by monitor.
When any part has approached the end of its life, an alarm can be output by self diagnosis to prevent a fault.
(Use the life check of this function as a guideline since the life except the main circuit capacitor is calculated theoretically.)
For the life check of the main circuit capacitor, the alarm signal (Y90) will not be output if a measuring method of (4) is not performed.

Parameter number	Name	Initial value	Setting range	Description
255	**Life alarm status display**	0	(0 to 15)	Displays whether the control circuit capacitor, main circuit capacitor, cooling fan, and each parts of the inrush current limit circuit has reached the life alarm output level or not. (Reading only)
256	**Inrush current limit circuit life display**	100%	(0 to 100%)	Displays the deterioration degree of the inrush current limit circuit. (Reading only)
257	**Control circuit capacitor life display**	100%	(0 to 100%)	Displays the deterioration degree of the control circuit capacitor. (Reading only)
258	**Main circuit capacitor life display**	100%	(0 to 100%)	Displays the deterioration degree of the main circuit capacitor. (Reading only) The value measured by *Pr.259* is displayed.
259	**Main circuit capacitor life measuring**	0	0, 1 (2, 3, 8, 9)	Setting "1" and turning the power supply off starts the measurement of the main circuit capacitor life. When the *Pr.259* value is "3" after power-ON again, the measuring is completed. Writes deterioration degree in *Pr.258*.

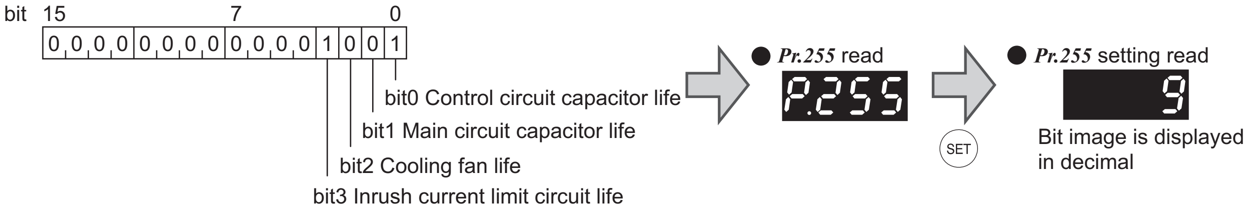
The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

REMARKS

- Since repeated inrush currents at power ON will shorten the life of the converter circuit, frequent starts and stops of the magnetic contactor must be avoided.

(1) Life alarm display and signal output (Y90 signal, *Pr.255*)

- Whether any of the control circuit capacitor, main circuit capacitor and inrush current limit circuit has reached the life alarm output level or not can be checked by *Pr.255 Life alarm status display* and life alarm signal (Y90).



Pr.255 (decimal)	Bit (binary)	Inrush Current Suppression Circuit Life	Cooling Fan Life	Main Circuit Capacitor Life	Control Circuit Capacitor Life
15	1111	○	○	○	○
14	1110	○	○	○	×
13	1101	○	○	×	○
12	1100	○	○	×	×
11	1011	○	×	○	○
10	1010	○	×	○	×
9	1001	○	×	×	○
8	1000	○	×	×	×
7	0111	×	○	○	○
6	0110	×	○	○	×
5	0101	×	○	×	○
4	0100	×	○	×	×
3	0011	×	×	○	○
2	0010	×	×	○	×
1	0001	×	×	×	○
0	0000	×	×	×	×

○: With warnings, ×: Without warnings

- The life alarm signal (Y90) turns ON when any of the control circuit capacitor, main circuit capacitor, cooling fan and inrush current limit circuit reaches the life alarm output level.
- For the terminal used for the Y90 signal, set "90" (positive logic) or "190" (negative logic) to any of *Pr.190 to Pr.192 (output terminal function selection)*.

NOTE

- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

(2) Inrush current limit circuit life display *(Pr.256)*

- The life of the inrush current limit circuit (relay, contactor and inrush resistor) is displayed in *Pr.256*.
- Activation of inrush current limit resistor circuit is counted. It is counted every 10,000 times (1%) and counts down from 100% (0 time).
  As soon as 10% (900,000 times) is reached, *Pr.255* bit 3 is turned ON and also an alarm is output to the Y90 signal.
  The inrush current limit resistor circuit activates under the following conditions:
  - At power-ON
  - At undervoltage occurrence *(Refer to page 271)*
  - At drive unit reset

(3) Control circuit capacitor life display *(Pr.257)*

- The deterioration degree of the control circuit capacitor is displayed in *Pr.257* as a life.
- In the operating status, the control circuit capacitor life is calculated from the energization time and temperature, and is counted down from 100%.
  As soon as the control circuit capacitor life falls below 10%, *Pr.255* bit 0 is turned ON and also an alarm is output to the Y90 signal.

(4) Main circuit capacitor life display *(Pr.258, Pr.259)*

- The deterioration degree of the control circuit capacitor is displayed in *Pr.258* as a life.
- On the assumption that the main circuit capacitor capacitance at factory shipment is 100%, the capacitor life is displayed in *Pr.258* every time measurement is made.
  When the measured value falls to or below 85%, *Pr.255* bit 1 is turned ON and also an alarm is output to the Y90 signal.
- Measure the capacitor capacity according to the following procedure and check the deterioration level of the capacitor capacity.

1) Check that the motor is connected and at a stop.
2) Set "1" (measuring start) in *Pr.259*.
3) Switch power OFF. The drive unit applies DC voltage to the motor to measure the capacitor capacity when the drive unit turns OFF.
4) After confirming that the LED of the operation panel is OFF, power ON again. (When using the 24V external power supply, turn ON the power again after "EV" appears.)
5) Check that "3" (measuring completion) is set in *Pr.259,* read *Pr.258*, and check the deterioration degree of the main circuit capacitor.

Pr.259	Description	Remarks
0	No measurement	Initial value
1	Measurement start	Measurement starts when the power supply is switched OFF.
2	During measurement	Only displayed and cannot be set
3	Measurement complete	
8	Forced end	
9	Measurement error	

REMARKS

- When the main circuit capacitor life is measured under the following conditions, "forced end" (*Pr.259* = "8") or "measuring error" (*Pr.259* ="9") occurs or it remains in "measuring start" (*Pr.259* = "1"). Therefore, do not measure in such case. In addition, even when "measurement completion" (*Pr.259* = "3") is confirmed under the following conditions, normal measurement can not be done.
  (a) FR-HC2, FR-CV is connected.
  (b) DC power supply is connected to the terminal P/+ and N/-.
  (c) The power supply switched ON during measurement.
  (d) The motor is not connected to the drive unit.
  (e) The motor is running (coasting).
  (f) The drive unit is tripped or a fault occurred when power is OFF.
  (g) The drive unit output is shut off with the MRS signal and SON signal.
  (h) The start command is given while measuring.
  (i) The parameter unit (FR-PU07) is connected.
  (j) Use terminal PC as power supply.
  (k) I/O terminal of the control terminal block is ON (continuity).
  (l) "EV" is displayed on the operation panel. (The main circuit power supply is OFF and the 24V external power supply is ON.)
  (When FR-E7DS is mounted. *Refer to page 316*)
- Turning the power ON during measuring before LED of the operation panel turns OFF, it may remain in "measuring" (*Pr.259* = "2") status. In such case, carry out operation from step 2.
- The motor shaft may move during measurement. Confirm in advance that the motor shaft movement will not cause any problems.

POINT

For accurate life measurement of the main circuit capacitor, wait 3 hours or longer after turning OFF. The temperature left in the main circuit capacitor affects measurement.

⚠ WARNING

⚠ **When measuring the main circuit capacitor capacity (*Pr.259 Main circuit capacitor life measuring* = "1"), the DC voltage is applied to the motor for 1s at powering OFF. Never touch the motor terminal, etc. right after powering OFF to prevent an electric shock.**

(5) Cooling fan life display

- The cooling fan speed of 50% or less is detected and "FN" is displayed on the operation panel and parameter unit (FR-PU07). As an alarm display, *Pr. 255* bit2 is turned on and also an alarm is output to the Y90 signal.

NOTE

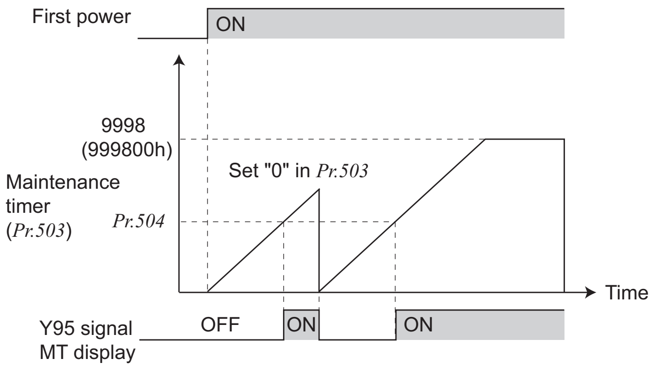
- **For replacement of each part, contact the nearest Mitsubishi FA center.**

4.20.3 Maintenance timer alarm (Pr.503, Pr.504)

When the cumulative energization time of the drive unit reaches the parameter set time, the maintenance timer output signal (Y95) is output.  (MT) is displayed on the operation panel.
This can be used as a guideline for the maintenance time of peripheral devices.

Parameter number	Name	Initial value	Setting range	Description
503	Maintenance timer	0	0 (1 to 9998)	Displays the cumulative energization time of the drive unit in 100h increments. (Reading only) When *Pr. 503* = "1 to 9998", writing the setting value of "0" clears the cumulative energization time. (Writing is disabled when *Pr. 503* = "0".)
504	Maintenance timer alarm output set time	9999	0 to 9998	Time taken until when the maintenance timer alarm output signal (Y95) is output.
			9999	No function

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*



- The cumulative energization time of the drive unit is stored into the EEPROM every hour and is displayed in *Pr.503 Maintenance timer* in 100h increments. *Pr.503* is clamped at 9998 (999800h).
- When the *Pr.503* value reaches the time set to *Pr.504 Maintenance timer alarm output set time* (100h increments), the maintenance timer alarm output signal (Y95) is output.
- For the terminal used for the Y95 signal output, assign the function by setting "95" (positive logic) or "195" (negative logic) to any of *Pr.190 to Pr.192 (output terminal function selection)*.

NOTE

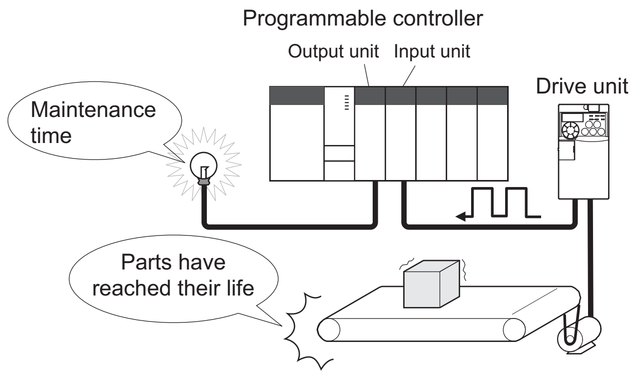
- **The cumulative energization time is counted every hour. The energization time of less than 1h is not counted.**
- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.190 to Pr.192 (output terminal function selection) *Refer to page 144*

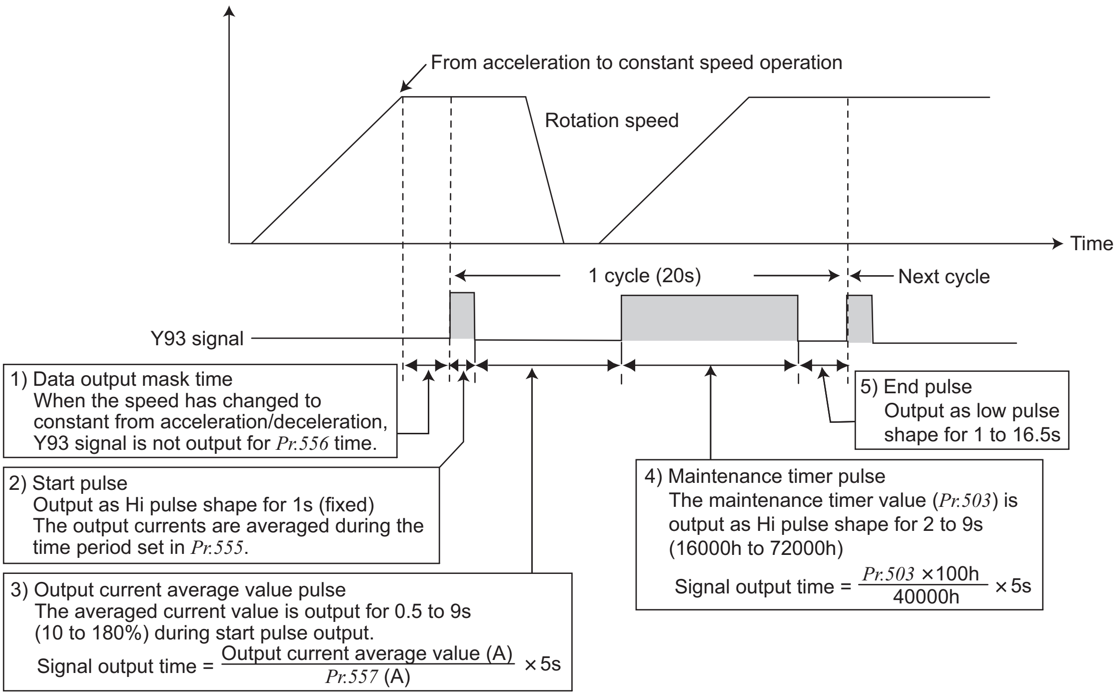
4.20.4 Current average value monitor signal (Pr.555 to Pr.557)

The average value of the output current during constant speed operation and the maintenance timer value are output as a pulse to the current average value monitor signal (Y93).
The pulse width output to the I/O module of the programmable controller or the like can be used as a guideline due to abrasion of machines and elongation of belt and for aged deterioration of devices to know the maintenance time.
The current average value monitor signal (Y93) is output as pulse for 20s as 1 cycle and repeatedly output during constant speed operation.



Parameter number	Name	Initial value	Setting range	Description
555	**Current average time**	1s	0.1 to 1.0s	Time taken to average the current during start pulse output (1s).
556	**Data output mask time**	0s	0 to 20s	Time for not obtaining (mask) transient state data.
557	**Current average value monitor signal output reference current**	Rated motor current	0 to 500A	Reference (100%) for outputting the signal of the current average value.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
The above parameters allow its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.
* *Refer to page 307* for the rated motor current.



- The pulse output of the current average value monitor signal (Y93) is shown above.
- For the terminal used for the Y93 signal output, assign the function by setting "93" (positive logic) or "193" (negative logic) to *Pr.190 and Pr.191 (output terminal function selection)*. The function can not be assigned to *Pr.192 ABC terminal function selection*.

1) Setting of *Pr.556 Data output mask time*
The output current is unstable (transient state) right after the operation is changed from the acceleration/deceleration state to the constant speed operation. Set the time for not obtaining (mask) transient state data in *Pr.556*.

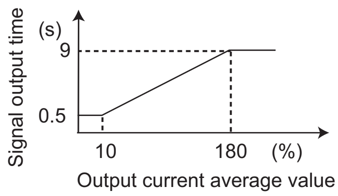
2) Setting of *Pr.555 Current average time*

The average output current is calculated during Hi output of start pulse (1s). Set the time taken to average the current during start pulse output in *Pr.555*.

3) Setting of *Pr.557 Current average value monitor signal output reference current*

Set the reference (100%) for outputting the signal of the current average value. Obtain the time to output the signal from the following calculation.

$$\frac{\textbf{Output current average value}}{\textbf{\textit{Pr.557} setting}} \times \textbf{5s} \quad \textbf{(Output current average value 100\%/5s)}$$



Note that the output time range is 0.5 to 9s and the output time is either of the following values when the output current average value is the corresponding percentage of the *Pr.557* setting.

Less than 10% ... 0.5s, more than 180% ... 9s

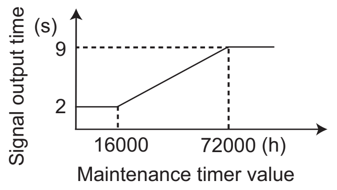
Example)when *Pr.557* = 10A and the average value of output current is 15A

As 15A/10A × 5s=7.5, the current average value monitor signal is output as low pulse shape for 7.5s.

4) Setting of *Pr.503 Maintenance timer*

After the output current average value is output as low pulse shape, the maintenance timer value is output as high pulse shape. The output time of the maintenance timer value is obtained from the following calculation.

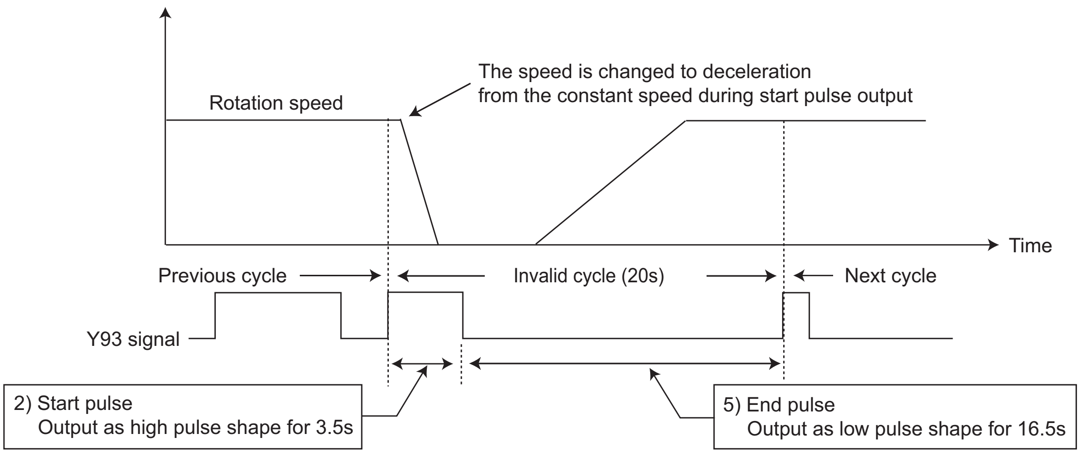
$$\frac{\textbf{\textit{Pr.503}} \times \textbf{100}}{\textbf{40000h}} \times \textbf{5s} \quad \textbf{(Maintenance timer value 100\%/5s)}$$



Note that the output time range is 2 to 9s, and it is 2s when the *Pr.503* setting is less than 16000h and 9s when exceeds 72000h.

REMARKS

- Mask of data output and sampling of output current are not performed during acceleration/deceleration.
- When the speed is changed to acceleration/deceleration from constant speed during start pulse output, the data is judged as invalid, the start pulse is output as high pulse shape for 3.5s, and the end signal is output as low pulse shape for 16.5s.
  The signal is output for at least 1 cycle even when acceleration/deceleration state continues after the start pulse output is completed.



- When the output current value (drive unit output current monitor) is 0A on completion of the 1 cycle signal output, the signal is not output until the speed becomes constant next time
- After completing one cycle of signal outputs in acceleration/deceleration, the current average value monitor signal (Y93) is output as Low output (no data output) for 20s.

NOTE

- **Under position control, current average monitor is not available.**
- **Changing the terminal assignment using *Pr.190 to Pr.192 (output terminal function selection)* may affect the other functions. Set parameters after confirming the function of each terminal.**

Parameters referred to

Pr.190 to Pr.192 (output terminal function selection) ☞ *Refer to page 144*

Pr.503 Maintenance timer ☞ *Refer to page 248*

4.20.5 Free parameter (Pr.888, Pr.889)

You can input any number within the setting range 0 to 9999.
For example, the number can be used:

- As a unit number when multiple units are used.
- As a pattern number for each operation application when multiple units are used.
- As the year and month of introduction or inspection.

Parameter number	Name	Initial value	Setting range	Description
888	**Free parameter 1**	9999	0 to 9999	Any values can be set. Data is held even if the drive unit power is turned OFF.
889	**Free parameter 2**	9999	0 to 9999	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*
The above parameters allow its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

REMARKS

Pr.888 and Pr.889 do not influence the drive unit operation.

4.20.6 Initiating a fault (Pr.997)

A fault is initiated by setting the parameter.
This function is useful to check how the system operates at a fault.

Parameter number	Name	Initial value	Setting range	Description
997 Ver.UP	Fault initiation	9999	16 to 18, 32 to 34, 48, 49, 64, 82, 96, 97, 112, 128, 129, 144, 160, 161, 176 to 179, 192, 197, 199 to 201, 208, 209, 211, 221, 241, 245, 246, 247, 253	The setting range is same with the one for fault data codes of the drive unit (which can be read through communication). Written data is not stored in EEPROM. When "0" is set, nothing happens.
			9999	The read value is always "9999". This setting does not initiate a fault.

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page Refer to page 182)*

Ver.UP ...... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

(1) Fault initiation *(Pr.997)*

- To initiate a fault, set the assigned number of the fault you want to initiate in *Pr.997 Fault initiation*.
- The value set in *Pr.997 Fault initiation* is not stored in EEPROM.
- When a fault occurs, the drive unit trips, and the fault is displayed and output (ALM).
- While the initiated fault is occurring, the fault is displayed as the latest fault in the faults history. After a reset, the faults history goes back to the previous status. (The fault generated by the fault initiation function is not saved in the faults history.)
- Perform drive unit reset to cancel the fault.

● Setting for *Pr.997 Fault initiation* and corresponding faults

Setting (Data code)	Fault	Setting (Data code)	Fault	Setting (Data code)	Fault
16(H10)	E.OC1	112(H70)	E.BE	199(HC7)	E.AIE
17(H11)	E.OC2	128(H80)	E.GF	200(HC8)	E.USB
18(H12)	E.OC3	129(H81)	E.LF	201(HC9)	E.SAF
32(H20)	E.OV1	144(H90)	E.OHT	208(HD0)	E.OS
33(H21)	E.OV2	160(HA0)	E.OPT	209(HD1)	E.OSD
34(H22)	E.OV3	161(HA1)	E.OP1	211(HD3)	E.OD
48(H30)	E.THT	176(HB0)	E.PE	221(HDD)	E.OA
49(H31)	E.THM	177(HB1)	E.PUE	241(HF1)	E.1
64(H40)	E.FIN	178(HB2)	E.RET	245(HF5)	E.5
82(H52)	E.ILF	179(HB3)	E.PE2	246(HF6)	E.6
96(H60)	E.OLT	192(HC0)	E.CPU	247(HF7)	E.7
97(H61)	E.SOT	197(HC5)	E.IOH	253(HFD)	E.13

REMARKS

- If a fault is already occurring in the drive unit, a fault cannot be initiated by *Pr.997*.
- The retry function is invalid for the fault initiated by the fault initiation function.
- If another fault occurs after a fault has been initiated, the fault indication does not change.
  The fault is not saved in the faults history either.

4.20.7 Batch setting Mitsubishi HMI (GOT) connection parameters (Pr. 999)

- Communication parameters for the Mitsubishi HMI (GOT) connection can be set as a batch.
- Multiple parameters are changed automatically. Users do not have to consider each parameter number. (Parameter setting mode)

Parameter number	Name	Initial value	Setting range	Description
999 Ver.UP	**Automatic parameter setting**	9999 *	10	GOT initial setting (PU connector)
			9999	No action

* The read value is always "9999."

Ver.UP .... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

(1) Automatic parameter setting *(Pr. 999)*

- Setting *Pr. 999* = "10" will automatically set the communication parameters required to connect a GOT to the PU connector.
- To operate in the parameter setting mode, go to "AUTO" → "GOT", then write "1".

The following tables show which parameters are changed in each of the automatic parameter settings.

NOTE

- If the automatic setting is performed with *Pr. 999* or the parameter setting mode, the listed settings including the changed parameter settings (changed from the initial setting) will be automatically changed. Before performing the automatic setting, confirm that changing the listed parameters will not cause any problem.

●GOT initial setting (PU connector) (*Pr. 999* = "10")

Parameter number	Name	Initial value	Automatically set to	Refer to Page
79	Operation mode selection	0	0	*186, 194*
118	PU communication speed	192	192	*204, 222*
119	PU communication stop bit length	1	10	*204, 222*
120	PU communication parity check	2	1	*204, 222*
121	Number of PU communication retries	1	9999	*205*
122	PU communication check time interval	0	9999	*205, 222*
123	PU communication waiting time	9999	0ms	*204*
124	PU communication CR/LF selection	1	1	*204*
340	Communication startup mode selection	0	1	*194*
549	Protocol selection	0	0	*204, 222*

REMARKS

- Always perform a drive unit reset after the initial setting.

(2) Automatic parameter setting using the operation panel (parameter setting mode)

Operation example	The communication setting parameters for the GOT connection with a PU connector are automatically set.

Operation	Display
1. Screen at power-ON The monitor display appears.	0 (MON, EXT)
2. Press PU/EXT to choose the PU operation mode.	PU indicator is lit. 0 (PU)
3. Press MODE to choose the parameter setting mode.	P. 1 (The parameter number read previously appears.)
4. Turn the setting dial until AUTO (AUTO) appears.	AUTO
5. Press SET to enter the automatic parameter setting mode.	A---
6. Turn the setting dial until GOT (GOT) appears.	GOT
7. Press SET to read the present set value. "0" appears.	0
8. Turn the setting dial to change it to the set value "1".	1
9. Press SET set.	1 ⇄ GOT

Flicker··· Parameter setting complete!!

- Turn the setting dial to read another parameter.
- Press SET to show the setting again.
- Press SET twice to show the next parameter.

? 1 ⇄ Er4 are displayed alternately ... Why?

☞ The drive unit is not in the PU operation mode.

1. Press PU/EXT.

   PU is lit and the monitor (4-digit LED) displays "0." (When *Pr. 79* ="0 (initial setting)")

2. Carry out operation from step 3 again.

4.21 Setting from the parameter unit and operation panel

Purpose	Parameter to set		Refer to page
To select rotation direction by RUN of the operation panel	RUN key rotation direction selection	Pr.40	255
To use the setting dial of the operation panel like a potentiometer for speed setting To provide key lock for operation panel	Operation panel operation selection	Pr.161	256
To change the magnitude of change of speed setting by the setting dial of the operation panel	Magnitude of speed change setting	Pr.295	259
To control the parameter unit buzzer	PU buzzer control	Pr.990	260
To adjust LCD contrast of the parameter unit	PU contrast adjustment	Pr.991	260

4.21.1 RUN key rotation direction selection (Pr.40)

Used to choose the direction of rotation by operating RUN of the operation panel.

Parameter number	Name	Initial value	Setting range	Description
40	RUN key rotation direction selection	0	0	Forward rotation
			1	Reverse rotation

The above parameters can be set when *Pr.160 Extended function display selection* = "0" *(Refer to page 182)*

4

PARAMETERS

4.21.2 Setting-dial potentiometer mode/key lock operation selection (Pr.161)

The setting dial of the operation panel can be used for setting like a potentiometer.
The key operation of the operation panel can be disabled.

Parameter number	Name	Initial value	Setting range	Description	
161	**Speed setting/key lock operation selection**	0	0	Setting dial speed setting mode	Key lock invalid
			1	Setting dial potentiometer mode	
			10	Setting dial speed setting mode	Key lock valid
			11	Setting dial potentiometer mode	

The above parameters can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

(1) Using the setting dial to set the speed

Operation example **Operate at 900r/min**

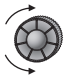
Operation — Display

1. Screen at power-ON
   The monitor display appears.

2. Press (PU/EXT) to choose the PU operation mode.

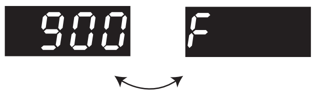
(PU/EXT) PU indicator is ON.

3. Turn  to display the speed you want to set.
   The speed flickers for about 5s

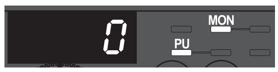


4. While the value is flickering, press (SET) to set the speed.
   (If you do not press (SET), the value flickers for about 5s and the display then returns to "0" (0r/ min). In that case, go back to "operation step 3" and set the speed again.)
   The value flickers for about 3s and the display then returns to "0" (monitor display).

(SET)



Flicker... Speed setting complete!!
After 3s, the monitor display appears.

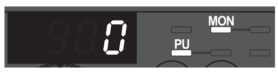


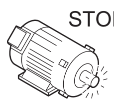
5. Start → acceleration → constant speed
   Press (RUN) to operation.
   The speed value on the display increases in *Pr.7 Acceleration time*, and "900" (900r/min) appears.

(RUN)

6. To change the set speed, perform the steps 3 and 4. (Starting from the previously set speed)
7. Deceleration → Stop
   Press (STOP/RESET) to stop the operation.
   The speed value on the display decreases in *Pr.8 Deceleration time*, and the motor stops running with "0" (0r/min) displayed.

(STOP/RESET)





REMARKS

If (SET) is not pressed within 5s after  is turned, the operation may not performed at the set speed.

(2) Using the setting dial like a potentiometer to set the speed

Operation example	Changing the speed from 0r/min to 1800r/min during operation

Operation / **Display**

1. Screen at power-ON
   The monitor display appears.
   Display: 0 (MON, EXT)

2. Press (PU/EXT) to choose the PU operation mode.
   Display: PU indicator is ON. 0 (PU)

3. Press (MODE) to choose the parameter setting mode.
   Display: PRM indicator is ON. P. 1 (PRM)
   (The parameter number read previously appears.)

4. Turn the dial until P. 161 *(Pr.161)* appears.
   Display: P. 161

5. Press (SET) to read the currently set value.
   "0"(initial value) appears.
   Display: 0

6. Turn the dial to change it to the set value "1".
   Display: 1

7. Press (SET) to set.
   Display: 1 ↔ P. 161
   Flicker... Parameter setting complete!!

8. Mode/monitor check
   Press (MODE) twice to choose the monitor/speed monitor.
   Display: 0 (MON, PU)

9. Press (RUN) to start the drive unit.
   Display: 0 (RUN, MON, PU)

10. Turn the dial until "1800" appears.
    The flickering speed is the set speed.
    You need not press (SET).
    Display: The frequency flickers for about 5s. 0 → 1800

REMARKS

- If the display changes from flickering "1800" to "0", the setting of *Pr.161 Speed setting/key lock operation selection* may not be "1".
- Independently of whether the drive unit is running or at a stop, the speed can be set by merely turning the dial.
- When the speed is changed, it will be stored in EEPROM as the set speed after 10s.

(3) Disable the setting dial and key operation of the operation panel (Press [MODE] long (2s))

- Operation using the setting dial and key of the operation panel can be invalid to prevent parameter change, and unexpected start or speed setting.
- Set "10 or 11" in *Pr.161*, then press MODE for 2s to make the setting dial and key operation invalid.
- When the setting dial and key operation are invalid, HOLd appears on the operation panel. If dial or key operation is attempted while dial and key operation are invalid, HOLd appears. (When dial or key is not touched for 2s, monitor display appears.)
- To make the setting dial and key operation valid again, press MODE for 2s.

REMARKS

- Even if the setting dial and key operation are disabled, the monitor display and STOP RESET are valid.

NOTE

- **Release the operation lock to release the PU stop by key operation.**
- **When setting speed by turning the setting dial, the speed goes up to the set value of *Pr.1 Maximum setting* (initial value: 3000r/min). Adjust *Pr.1 Maximum setting* according to the application.**

4.21.3 Magnitude of speed change setting (Pr.295)

Setting this parameter increases the magnitude of speed which changes according to the rotated amount of the setting dial, improving operability.

Parameter number	Name	Initial value	Setting range	Description
295 *1	**Magnitude of speed change setting**	0	0	Function invalid
			0.01 *2	The minimum varying width when the set speed is changed by the setting dial can be set.
			0.10 *2	
			1.00	
			10.00	

The above parameter can be set when *Pr.160 Extended function display selection* = "0". *(Refer to page 182)*

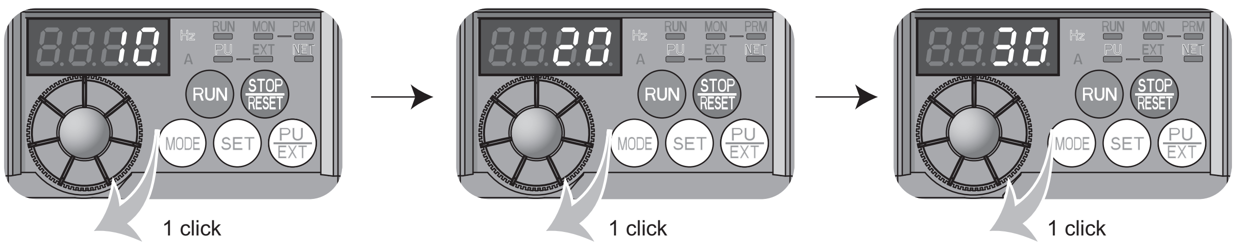
*1 The above parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

*2 Valid when the frequency increments or machine speed increments is selected with *Pr.37* or *Pr.144*. (*Refer to page 153*)

(1) Basic operation

When a value other than "0" is set in *Pr.295*, the minimum varying width when the set speed is changed by the setting dial can be set.
For example, when "10" is set in *Pr.295*, one click (one dial gauge) of the setting dial changes the speed in increments of 10r/min→20r/min→30r/min.

When ***Pr. 295*** = "1"



* One rotation of the setting dial equals to 24 clicks (24 dial gauges).

REMARKS

- When machine speed display is selected with *Pr.37*, the minimum increments of the magnitude of change is determined by *Pr.295* as well. Note that the setting value may differ as speed setting changes the set machine speed and converts it to the speed display again.
- When the set frequency is 100 or more, frequency is displayed in 0.1 increments. Therefore, the minimum varying width is 0.1 even when *Pr.295* < 0.1.
- When the machine speed setting is 1000 or more, frequency is displayed in 1 increments. Therefore, the minimum varying width is 1 even when *Pr.295* < 1.

NOTE

- **For *Pr.295* , unit is not displayed .**
- **This parameter is valid only in the set speed mode. When other speed-related parameters are set, it is not activated.**
- **While the frequency setting is being selected, setting "10" changes the frequency setting in 10Hz increments. Be cautions of the excess speed (in potentiometer mode).**

4.21.4 Buzzer control (Pr.990)

You can make the buzzer "beep" when you press the key of the parameter unit (FR-PU07).

Parameter number	Name	Initial value	Setting range	Description
990	**PU buzzer control**	1	0	Without buzzer
			1	With buzzer

The above parameter can be set when *Pr.160 Extended function display selection* = "0". (*Refer to page 182*)
The above parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

REMARKS

- When with buzzer is set, the buzzer sounds if a drive unit fault occurs.

4.21.5 PU contrast adjustment (Pr.991)

Contrast adjustment of the LCD of the parameter unit (FR-PU07) can be performed.
Decreasing the setting value makes the contrast lighter.

Parameter number	Name	Initial value	Setting range	Description
991	**PU contrast adjustment**	58	0 to 63	0: Light ↓ 63: Dark

The above parameter is displayed as simple mode parameter only when the parameter unit FR-PU07 is connected.
The above parameter allows its setting to be changed during operation in any operation mode even if "0" (initial value) is set in *Pr.77 Parameter write selection*.

4.22 Parameter clear/ All parameter clear

POINT

- Set "1" in *Pr.CL Parameter clear, ALLC All parameter clear* to initialize all parameters. (Parameters are not cleared when "1" is set in *Pr.77 Parameter write selection*.)
- Refer to the extended parameter list on *page 52* for parameters cleared with this operation.

Operation	Display
1. Screen at power-ON The monitor display appears.	0 (MON, EXT)
2. Press (PU/EXT) to choose the PU operation mode.	PU indicator is ON. 0 (PU)
3. Press (MODE) to choose the parameter setting mode.	PRM indicator is ON. P. 1 (PRM) (The parameter number read previously appears.)
4. Turn (dial) until Pr.CL (ALLC) appears.	Parameter clear Pr.CL All parameter clear ALLC
5. Press (SET) to read the currently set value. "0"(initial value) appears.	0
6. Turn (dial) to change it to the set value "1".	1
7. Press (SET) to set.	1 Parameter clear Pr.CL All parameter clear ALLC

Flicker... Parameter setting complete!!

- Turn (dial) to read another parameter.
- Press (SET) to show the setting again.
- Press (SET) twice to show the next parameter.

Setting	Description
0	Not executed.
1	Set parameters back to the initial values. (Parameter clear sets back all parameters except *calibration parameters, terminal function selection parameters* to the initial values.) Refer to the parameter list on *page 52* for availability of parameter clear and all parameter clear.

REMARKS

? 1 and Er4 are displayed alternately ... Why?

☞The drive unit is not in the PU operation mode.

☞PU connector or USB connector is used.

Remove the PU cable and the USB cable, and carry out the operation from step 2 again.

- Stop the drive unit. Parameter clear is unavailable when the drive unit is running, and will cause the write disable error.

4

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4.23 Initial value change list

Displays and sets the parameters changed from the initial value.

Operation — **Display**

1. Screen at power-ON

   The monitor display appears.

   Display: 0 (MON, EXT)

2. Press (PU/EXT) to choose the PU operation mode.

   PU indicator is ON.

   Display: 0 (PU)

3. Press (MODE) to choose the parameter setting mode.

   PRM indicator is ON.

   Display: P. 1 (PRM)

   (The parameter number read previously appears.)

4. Turn (setting dial) until Pr.CH appears.

   Display: Pr.CH

5. Pressing (SET) changes to the initial value change list screen.

   Display: P.---

   * It may take several seconds for creating the initial value change list. "P.---" flickers while creating the list.

6. Turning (setting dial) displays the parameter number changed.

   Display: P. 7

   - Press (SET) to read the currently set value.

     Display: 3.00

     Turn (setting dial) and press (SET) to change the setting.

     (Refer to step 6 and 7 on page 51)

     Display: 4.00 ⇄ P. 7

     Flicker... Parameter setting complete!!

   - Turn (setting dial) to read another parameter.

     Display: P. 11

   - The display returns to P.--- after all parameters are displayed.

     Display: P.---

7. Pressing (SET) in P.--- status returns to the parameter setting mode.

   Display: Pr.CH

   - Turning (setting dial) sets other parameters.
   - Pressing (SET) displays the change list again.

NOTE

- **Calibration parameters *(C0 (Pr.900) to C7 (Pr.905)* are not displayed even they are changed from the initial settings.**
- **Only simple mode parameter is displayed when simple mode is set (*Pr.160* = 9999)**
- ***Pr.160* is displayed independently of whether the setting value is changed or not.**
- **When parameter setting is changed after creating the initial value change list, the setting will be reflected to the initial value change list next time.**

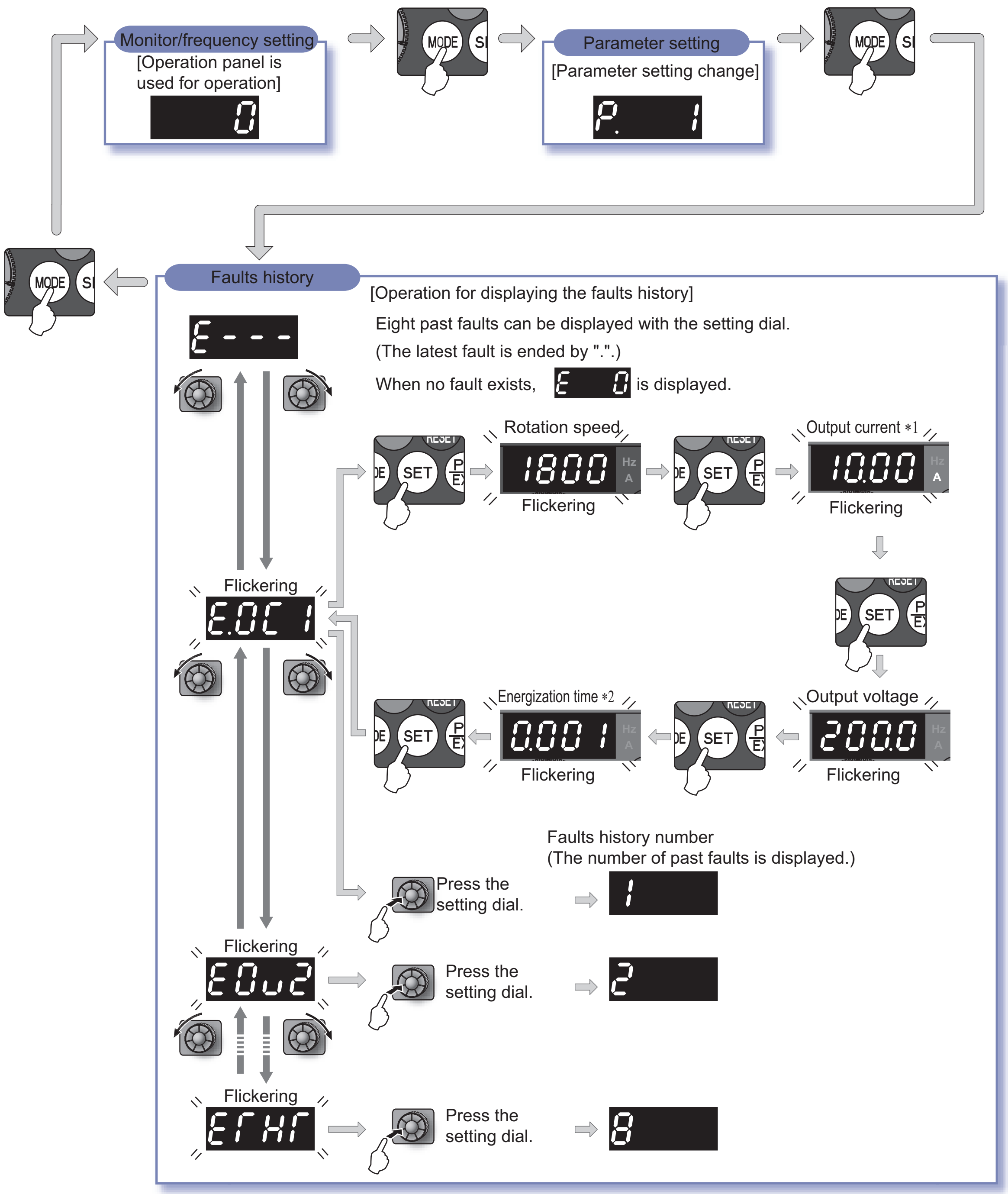
Parameters referred to

C0(Pr.900) FM terminal calibration *Refer to page 162*

C2(Pr.902) to C7(Pr.905) (Bias and gain of built-in frequency setting potentiometer) *Refer to page 173*

4.24 Check and clear of the faults history

(1) Check for the faults history



*1 When an overcurrent trip occurs by an instantaneous overcurrent, the monitored current value saved in the faults history may be lower than the actual current that has flowed.

*2 The cumulative energization time and actual operation time are accumulated from 0 to 65535 hours, then cleared, and accumulated again from 0. When the operation panel is used, the time is displayed up to 65.53 (65530h) in the indication of 1h = 0.001, and thereafter, it is added up from 0.

(2) Clearing procedure

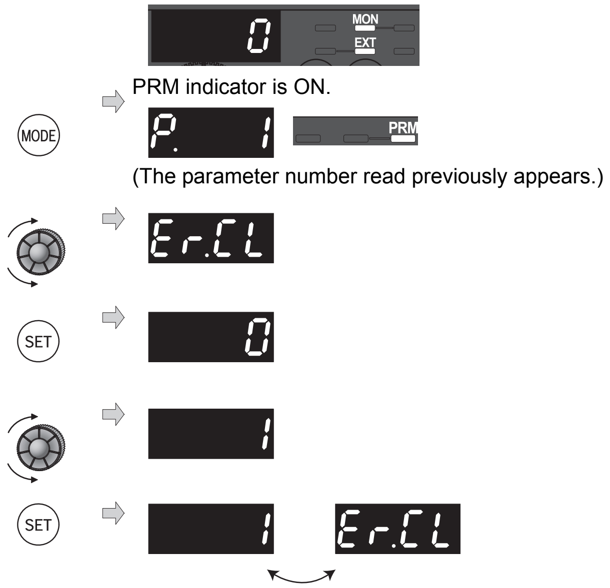
POINT

- Set "1" in *Er.CL Fault history clear* to clear the faults history.

Operation

1. Screen at power-ON
   The monitor display appears.
2. Press (MODE) to choose the parameter setting mode.
3. Turn until Er.CL (faults history clear) appears.
4. Press (SET) to read the currently set value.
   "0" (initial value) appears.
5. Turn to change it to the set value "1".
6. Press (SET) to set.

Display



Flicker... Faults history clear complete!!

- Turn to read another parameter.
- Press (SET) to show the setting again.
- Press (SET) twice to show the next parameter.

Parameter referred to

Pr.77 Parameter write selection *Refer to page 181*

5 TROUBLESHOOTING

This chapter provides the "TROUBLESHOOTING" of this product.
Always read the instructions before using the equipment.

When a fault occurs in the drive unit, the drive unit trips and the PU display automatically changes to one of the following fault or alarm indications.

If the fault does not correspond to any of the following faults or if you have any other problem, please contact your sales representative.

- Retention of fault output signal .... When the magnetic contactor (MC) provided on the input side of the drive unit is opened when a fault occurs, the drive unit's control power will be lost and the fault output will not be held.
- Fault or alarm indication .... When a fault or alarm occurs, the operation panel display automatically switches to the fault or alarm indication.
- Resetting method .... When a fault occurs, the drive unit output is kept stopped. Unless reset, therefore, the drive unit cannot restart. *(Refer to page 266)*
- When any fault occurs, take the appropriate corrective action, then reset the drive unit, and resume operation. Not doing so may lead to the drive unit fault and damage.

Drive unit fault or alarm indications are roughly categorized as below.

(1) Error message

A message regarding operational fault and setting fault by the operation panel and parameter unit (FR-PU07) is displayed. The drive unit does not trip.

(2) Warning

The drive unit does not trip even when a warning is displayed. However, failure to take appropriate measures will lead to a fault.

(3) Alarm

The drive unit does not trip. You can also output an alarm signal by making parameter setting.

(4) Fault

When a fault occurs, the drive unit trips and a fault signal is output.

REMARKS

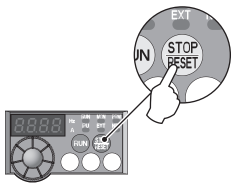
- Past eight faults can be displayed using the setting dial. *(Refer to page 48)*

5.1 Reset method of protective function

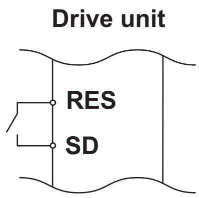
(1) Resetting the drive unit

The drive unit can be reset by performing any of the following operations. Note that the internal accumulated heat value of the electronic thermal relay function and the number of retries are cleared (erased) by resetting the drive unit.
Drive unit recovers about 1s after the reset is released.

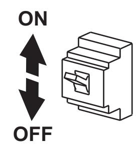
Operation 1: Using the operation panel, press  to reset the drive unit.
(This may only be performed when a fault occurs (*Refer to page 272* for fault.))



Operation 2: Turn ON the reset signal (RES) for more than 0.1s. (If the RES signal is kept ON, "Err." appears (flickers) to indicate that the drive unit is in a reset status.)



Operation 3: Switch power OFF once. After the indicator of the operation panel turns OFF, switch it ON again.



REMARKS

- Use the operation 1 or 2 to reset when using the 24V external power supply. (Drive unit with FR-E7DS mounted.) *(Refer to page 316)*
- OFF status of the start signal must be confirmed before resetting the drive unit fault. Resetting drive unit fault with the start signal ON restarts the motor suddenly.

5.2 List of fault or alarm indications

	Operation Panel Indication		Name	Refer to Page
Error message	E - - -	E- - -	Faults history	263
	HOLd	HOLD	Operation panel lock	268
	LOCd	LOCD	Password locked	268
	Er 1 to Er 4	Er1 to 4	Parameter write error	268
	Err.	Err.	Drive unit reset	269
Warning	OL	OL	Under torque limit	269
	oL	oL	Stall prevention	269
	rb	RB	Regenerative brake pre-alarm	270
	TH	TH	Electronic thermal relay function pre-alarm	270
	PS	PS	PU stop	270
	MT	MT	Maintenance signal output	270
	HP 1	HP1	Home position return setting error	270
	HP2	HP2	Home position return uncompleted	270
	Uu	UV	Undervoltage	271
	Eu	EV*1 Ver.UP	24V external power supply operation	271
	LP	LP	Stroke limit warning	271
Alarm	Fn	FN	Fan alarm	271
Fault	E.OC 1	E.OC1	Overcurrent trip during acceleration	272
	E.OC2	E.OC2	Overcurrent trip during constant speed	272
	E.OC3	E.OC3	Overcurrent trip during deceleration or stop	272
	E.Ou 1	E.OV1	Regenerative overvoltage trip during acceleration	273
	E.Ou2	E.OV2	Regenerative overvoltage trip during constant speed	273
	E.Ou3	E.OV3	Regenerative overvoltage trip during deceleration or stop	273
	E.THT	E.THT	Drive unit overload trip (electronic thermal relay function)	273
	E.THM	E.THM	Motor overload trip (electronic thermal relay function)	273
	E.FIn	E.FIN	Heatsink overheat	274
Fault	E.ILF	E.ILF	Input phase loss	274
	E.OLT	E.OLT	Stop by the torque limit	274
	E.SOT	E.SOT	Loss of synchronism detection	275
	E. bE	E. BE	Brake transistor alarm detection	275
	E. GF	E.GF	Output side earth (ground) fault overcurrent	275
	E. LF	E.LF	Output phase loss	275
	E.OHT	E.OHT	External thermal relay operation	276
	E.OPT	E.OPT	Option fault	275
	E.OP 1	E.OP1	Communication option fault	276
	E. 1	E.1	Option fault	276
	E. PE	E.PE	Parameter storage device fault	276
	E.PE2	E.PE2	Internal board fault	276
	E.PUE	E.PUE	PU disconnection	277
	E.rET	E.RET	Retry count excess	277
	E. 5/ E. 6/ E. 7/ E.CPU	E. 5/ E. 6/ E. 7/ E.CPU	CPU fault	277
	E.IOH	E.IOH	Inrush current limit circuit fault	277
	E.AIE	E.AIE	Analog input fault	277
	E. OS	E.OS	Overspeed occurrence	278
	E.OSd	E.OSD	Speed deviation excess detection	278
	E. Od	E.OD	Excessive position fault	278
	E. OA	E.OA	Acceleration error	278
	E.USb	E.USB	USB communication fault	278
	E.SAF	E.SAF	Internal circuit fault	279
	E. 13	E.13	Internal circuit fault	279

*1 Appears only when used with FR-E7DS.

Ver.UP .... Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

TROUBLESHOOTING

5

5.3 Causes and corrective actions

(1) Error message

A message regarding operational troubles is displayed. Output is not shutoff.

Operation panel indication	**HOLD**	HOLd
Name	Operation panel lock	
Description	Operation lock mode is set. Operation other than STOP RESET is invalid. *(Refer to page 258)*	
Check point	————	
Corrective action	Press MODE for 2s to release lock.	

Operation panel indication	**LOCD**	LOCd
Name	Password locked	
Description	Password function is active. Display and setting of parameter is restricted.	
Check point	————	
Corrective action	Enter the password in *Pr.297 Password lock/unlock* to unlock the password function before operating. *(Refer to page 183)*	

Operation panel indication	**Er1**	Er 1
Name	Write disable error	
Description	• You attempted to make parameter setting when *Pr.77 Parameter write selection* has been set to disable parameter write. • Speed jump setting range overlapped. • The PU and drive unit cannot make normal communication.	
Check point	• Check the setting of *Pr.77 Parameter write selection (Refer to page 181)* • Check the settings of *Pr.31 to Pr.36 (speed jump)*. *(Refer to page 116)* • Check the connection of the PU and drive unit.	

Operation panel indication	**Er2**	Er2
Name	Write error during operation	
Description	When parameter write was performed during operation with a value other than "2" (writing is enabled independently of operation status in any operation mode) is set in *Pr.77* and the STF (STR) is ON.	
Check point	• Check the *Pr.77* setting. *(Refer to page 181)* • Check that the drive unit is not operating.	
Corrective action	• Set "2" in *Pr.77*. • After stopping operation, make parameter setting.	

Operation panel indication	**Er3**	Er3
Name	Calibration error	
Description	Analog input bias and gain calibration values are too close.	
Check point	Check the settings of *C3, C4, C6 and C7 (calibration functions)*. *(Refer to page 173)*	

Operation panel indication	**Er4**	Er4
Name	Mode designation error	
Description	• Appears if a parameter setting is attempted in the External or NET operation mode with *Pr.77* ≠ "2". • Appears if a parameter setting is attempted when the command source is not at the operation panel.	
Check point	• Check that operation mode is PU operation mode. • Check the *Pr.77* setting. *(Refer to page 181)* • Check if FR Configurator (USB connector) or a parameter unit (FR-PU07) is connected when *Pr.551* = "9999 (initial setting)." • Check the *Pr.551* setting.	
Corrective action	• After setting the operation mode to the "PU operation mode", make parameter setting. *(Refer to page 186)* • After setting *Pr.77* = "2", make parameter setting. • Disconnect FR Configurator (USB connector) or the parameter unit (FR-PU07), and make parameter setting. • After setting *Pr.551* = "4", make parameter setting. *(Refer to page 195)*	

Operation panel indication	**Err.**	Err.
Name	Drive unit reset	
Description	• Executing reset using RES signal, or reset command from communication or PU • Displays at powering OFF.	
Corrective action	• Turn OFF the reset command	

(2) Warnings

When a warning occurs, the output is not shut off.

Operation panel indication	**OL**	OL	**FR-PU07**	**OL**
Name	Under torque limit			
Description	During acceleration	When the output current of the drive unit exceeds the torque limit operation level (*Pr.22 Torque limit level* and others), this function stops the increase in the speed until the overload current drops in order to prevent the drive unit from tripping by overcurrent. The speed increases again after the overload current drops lower than the torque limit operation level.		
	During constantspeed operation	When the output current of the drive unit exceeds the torque limit operation level (*Pr.22 Torque limit level* and others), this function decreases the speed until the overload current drops in order to prevent the drive unit from tripping by overcurrent. The speed goes back to the set speed after the overload current drops lower than the torque limit operation level.		
	During deceleration	When the output current of the drive unit exceeds the torque limit operation level (*Pr.22 Torque limit level* and others), this function stops the decrease in the speed until the overload current drops in order to prevent the drive unit from tripping by overcurrent. The speed decreases again after the overload current drops lower than the torque limit operation level.		
Check point	• Any of the acceleration time set by *Pr.7 Acceleration time*, deceleration time set by *Pr.8 Deceleration time*, and positioning acceleration/deceleration time set by *Pr.578 to Pr.591* is too short. • Check for torque shortage in a low-speed range. • Check if the acceleration/deceleration time in a low-speed range is too short. • Check that the load is not too heavy. • Are there any failure in peripheral devices? • Check that the *Pr.22 Torque limit level* is appropriate			
Corrective action	• Set a larger value in *Pr.7 Acceleration time*, *Pr.8 Deceleration time*, and positioning acceleration/deceleration time set in *Pr.578 to Pr.591*. *(Refer to page 125)* • Set a larger value in *Pr.785 PM control torque boost*. *(Refer to page 114)* S-PM • Set longer times in *Pr.791 Acceleration time in low-speed range* and *Pr.792 Deceleration time in low-speed range*. *(Refer to page 125)* • Reduce the load weight. • Set the torque limit operation current in *Pr.22 Torque limit level*. (The initial value differs according to the drive unit capacity and the motor being used.) Acceleration/deceleration time may change. Increase the torque limit operation level with *Pr.22 Torque limit level*, or disable the torque limit operation with *Pr.156 Torque limit selection*. (Operation at OL occurrence can be selected using *Pr.156*.) • Check the connection of the PM motor.			

Operation panel indication	**oL**	oL	**FR-PU07**	**oL**
Name	Stall prevention			
Description	During deceleration	• If the regenerative energy of the motor becomes excessive to exceed the regenerative energy consumption capability, this function stops the decrease in speed to prevent overvoltage trip. As soon as the regenerative energy has reduced, deceleration resumes. • If the regenerative energy of the motor becomes excessive when regeneration avoidance function is selected (*Pr.882* =1), this function increases the speed to prevent overvoltage trip. *(Refer to page 242)*		
Check point	• Check for sudden speed reduction. • Check that regeneration avoidance function *(Pr.882, Pr.883, Pr.885, Pr.886)* is used. *(Refer to page 242)*			
Corrective action	The deceleration time may change. Increase the deceleration time using *Pr.8 Deceleration time*.			

Operation panel indication	PS	PS	FR-PU07	PS
Name	PU stop			
Description	Stop with STOP/RESET of the PU is set in *Pr.75 Reset selection/disconnected PU detection/PU stop selection*. (*For Pr.75 refer to page 178.*)			
Check point	Check for a stop made by pressing STOP/RESET of the operation panel.			
Corrective action	Turn the start signal OFF and release with PU/EXT.			

Operation panel indication	RB	rb	FR-PU07	RB
Name	Regenerative brake pre-alarm			
Description	Appears if the regenerative brake duty reaches or exceeds 85% of the *Pr.70 Special regenerative brake duty* value. When the setting of *Pr.70 Special regenerative brake duty* is the initial value (*Pr.70* = "0"), this warning does not occur. If the regenerative brake duty reaches 100%, a regenerative overvoltage (E. OV_) occurs. The RBP signal can be simultaneously output with the [RB] display. For the terminal used for the RBP signal output, assign the function by setting "7 (positive logic) or 107 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*. *(Refer to page 144)*			
Check point	• Check that the brake resistor duty is not high. • Check that the *Pr.30 Regenerative function selection* and *Pr.70 Special regenerative brake duty* settings are correct.			
Corrective action	• Increase the deceleration time. • Check that the *Pr.30 Regenerative function selection* and *Pr.70 Special regenerative brake duty* settings.			

Operation panel indication	TH	TH	FR-PU07	TH
Name	Electronic thermal relay function pre-alarm			
Description	Appears if the cumulative value of the *Pr.9 Electronic thermal O/L relay* reaches or exceeds 85% of the preset level. If it reaches 100% of the *Pr.9 Electronic thermal O/L relay* setting, a motor overload trip (E. THM) occurs. The THP signal can be simultaneously output with the [TH] display. For the terminal used for THP signal output, assign the function by setting "8 (positive logic) or 108 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*. *(Refer to page 144)*			
Check point	• Check for large load or sudden acceleration. • Is the *Pr.9 Electronic thermal O/L relay* setting is appropriate? *(Refer to page 130)*			
Corrective action	• Reduce the load and speed of operation. • Set an appropriate value in *Pr.9 Electronic thermal O/L relay*. *(Refer to page 130)*			

Operation panel indication	MT	MT	FR-PU07	MT
Name	Maintenance signal output			
Description	Indicates that the cumulative energization time of the drive unit has reached a given time. When the setting of *Pr.504 Maintenance timer alarm output set time* is the initial value (*Pr.504* = "9999"), this warning does not occur.			
Check point	The *Pr.503 Maintenance timer* setting is larger than the *Pr.504 Maintenance timer alarm output set time* setting. *(Refer to page 248)*			
Corrective action	Setting "0" in *Pr.503 Maintenance timer* erases the signal.			

Operation panel indication	HP1, HP2	HP1, HP2	FR-PU07	—— GKR
Name	Home position return error			
Description	Appears when an error occurs during the home position return operation under position control. *(Refer to page 104)*			
Check point	Identify the cause of the error occurrence.			
Corrective action	Check the parameter setting, and check that the input signal is correct.			

Operation panel indication	**UV**	Uv	**FR-PU07**	**——**
Name	Undervoltage			
Description	If the power supply voltage of the drive unit decreases, the control circuit will not perform normal functions. In addition, the motor torque will be insufficient and/or heat generation will increase. To prevent this, if the power supply voltage decreases below about 115VAC this function stops the drive unit output and displays Uv . An alarm is reset when the voltage returns to normal.			
Check point	Check that the power supply voltage is normal.			
Corrective action	Check the power supply system equipment such as power supply.			

Operation panel indication	**EV** Ver.UP	Ev	**FR-PU07**	**——**
Name	24V external power supply operation			
Description	Flickers while the main circuit power is not supplied and the 24V external power is supplied when FR-E7DS is mounted.			
Check point	• Check if the 24V external power is supplied. • Check if the power supply for the drive unit (main circuit) is ON. Check if the power supply voltage is low. • Check if the jumper between terminal P/+ and P1 is removed.			
Corrective action	• Turn ON the power supply for the inverter (main circuit). • If Ev appears by turning ON the power supply of the drive unit (main circuit) while the external 24V power is supplied, check the power supply (for the main circuit). • Check if the jumper is installed securely between terminal P/+ and P1.			

Ver.UP ....Specifications differ according to the date assembled. *Refer to page 316* to check the SERIAL number.

Operation panel indication	**LP**	LP	**FR-PU07**	**——**	GKR
Name	Stroke limit warning				
Description	When the forward rotation stroke end (LSP) or the reverse rotation stroke end (LSN) signal is assigned to an input terminal, LP appears when the LSP or LSN signal is turned OFF and remains while the signal is in the OFF state. *(Refer to page 101)*				
Check point	Check if the LSP or LSN signal is turned OFF.				
Corrective action	Turn ON the LSP or LSN signal.				

(3) Alarm

When an alarm occurs, the output is not shut off. You can also output an alarm signal by making parameter setting.(Set "98" in any of *Pr. 190 to Pr. 192 (output terminal function selection)*. *Refer to page 144*).

Operation panel indication	**FN**	Fn	**FR-PU07**	**FN**
Name	Fan alarm			
Description	For the drive unit that contains a cooling fan, Fn appears on the operation panel when the cooling fan stops due to an alarm or different operation from the setting of *Pr. 244 Cooling fan operation selection*.			
Check point	Check the cooling fan for an alarm.			
Corrective action	Check for fan alarm. Please contact your sales representative.			

(4) Fault

When a fault occurs, the drive unit trips and a fault signal is output.

Operation panel indication	E.OC1		FR-PU07	OC During Acc
Name	Overcurrent trip during acceleration			
Description	When the drive unit output current reaches or exceeds approximately 230% of the rated current during acceleration, the protective circuit is activated and the drive unit trips.			
Check point	• Check for sudden acceleration. • Check that the downward acceleration time is not long for the lift. • Check for output short-circuit/ground fault. • Check if the torque limit operation level is set too high. • Check that the drive unit capacity matches with the motor capacity. • Check if a start command is given to the drive unit while the motor is coasting. • Check if the three-phase (U, V, and W) wiring on the output side (load side) of the drive unit is correct. (Check for phase loss.)			
Corrective action	• Increase the acceleration time. (Shorten the downward acceleration time for the lift.) • When "E.OC1" is always lit at starting, disconnect the motor once and start the drive unit. If "E.OC1" is still ON, contact your sales representative. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Lower the setting of torque limit operation level. *(Refer to page 111)* • Choose drive unit and motor capacities that match. • Input a start command after the motor stops. • Wire the cables properly.			

Operation panel indication	E.OC2		FR-PU07	Stedy Spd OC
Name	Overcurrent trip during constant speed			
Description	When the drive unit output current reaches or exceeds approximately 230% of the rated current during constant speed operation, the protective circuit is activated and the drive unit trips.			
Check point	• Check for sudden load change. • Check for output short-circuit/ground fault. • Check if the torque limit operation level is set too high. • Check that the drive unit capacity matches with the motor capacity. • Check if a start command is given to the drive unit while the motor is coasting. • Check if the three-phase (U, V, and W) wiring on the output side (load side) of the drive unit is correct. (Check for phase loss.)			
Corrective action	• Keep load stable. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Lower the setting of torque limit operation level. *(Refer to page 111)* • Choose drive unit and motor capacities that match. • Input a start command after the motor stops. • Wire the cables properly.			

Operation panel indication	E.OC3		FR-PU07	OC During Dec
Name	Overcurrent trip during deceleration or stop			
Description	When the drive unit output current reaches or exceeds approximately 230% of the rated drive unit current during deceleration (other than acceleration or constant speed), the protective circuit is activated and the drive unit trips.			
Check point	• Check for sudden speed reduction. • Check for output short-circuit/ground fault. • Check for too fast operation of the motor's mechanical brake. • Check if the torque limit level is set too high. • Check that the drive unit capacity matches with the motor capacity. • Check if a start command is given to the drive unit while the motor is coasting. • Check if the three-phase (U, V, and W) wiring on the output side (load side) of the drive unit is correct. (Check for phase loss.)			
Corrective action	• Increase the deceleration time. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Check the mechanical brake operation. • Lower the setting of torque limit level. *(Refer to page 111)* • Choose drive unit and motor capacities that match. • Input a start command after the motor stops. • Wire the cables properly.			

Operation panel indication	E.OV1		FR-PU07	OV During Acc
Name	Regenerative overvoltage trip during acceleration			
Description	If regenerative energy causes the drive unit's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated and the drive unit trips. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	• Check for too slow acceleration. (e.g. during downward acceleration in vertical lift load)			
Corrective action	• Decrease the acceleration time. • Check that regeneration avoidance function *(Pr.882, Pr.883, Pr.885, Pr.886)* is used. *(Refer to page 242)*			

Operation panel indication	E.OV2		FR-PU07	Stedy Spd OV
Name	Regenerative overvoltage trip during constant speed			
Description	If regenerative energy causes the drive unit's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the drive unit output. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	• Check for sudden load change.			
Corrective action	• Keep load stable. • Check that regeneration avoidance function *(Pr.882, Pr.883, Pr.885, Pr.886)* is used. *(Refer to page 242)* • Use the brake resistor, brake unit or power regeneration common converter (FR-CV) as required.			

Operation panel indication	E.OV3		FR-PU07	OV During Dec
Name	Regenerative overvoltage trip during deceleration or stop			
Description	If regenerative energy causes the drive unit's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the drive unit output. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	Check for sudden speed reduction.			
Corrective action	• Increase the deceleration time. (Set the deceleration time which matches the moment of inertia of the load) • Longer the brake cycle. • Use regeneration avoidance function *(Pr.882, Pr.883, Pr.885, Pr.886)*. *(Refer to page 242)* • Use the brake resistor, brake unit or power regeneration common converter (FR-CV) as required.			

Operation panel indication	E.THT		FR-PU07	Inv. Overload
Name	Drive unit overload trip (electronic thermal relay function)			
Description	If the temperature of the output transistor element exceeds the protection level under the condition that a current not less than the rated drive unit current flows and overcurrent trip does not occur (230% or less), the electronic thermal relay activates to stop the drive unit output. (Overload capacity 150% 60s, 200% 3s)			
Check point	• Check that acceleration/deceleration time is not too short. • Check the motor for use under overload. • Check for too high surrounding air temperature.			
Corrective action	• Increase acceleration/deceleration time. • Reduce the load weight. • Set the surrounding air temperature to within the specifications.			

Operation panel indication	E.THM		FR-PU07	Motor Ovrload
Name	Motor overload trip (electronic thermal relay function) *1			
Description	The electronic thermal relay function in the drive unit detects motor overheat due to overload or reduced cooling capability during low-speed operation and pre-alarm (TH display) is output when the integrated value reaches 85% of the *Pr.9 Electronic thermal O/L relay* setting and the protection circuit is activated to stop the drive unit output when the integrated value reaches the specified value.			
Check point	• Check the motor for use under overload. • Check that torque limit operation setting is correct.			
Corrective action	• Reduce the load weight. • Check that torque limit operation setting is correct. *(Refer to page 111)*			

*1 Resetting the drive unit initializes the internal thermal integrated data of the electronic thermal relay function.

Operation panel indication	E.FIN		FR-PU07	H/Sink O/Temp
Name	Heatsink overheat			
Description	If the heatsink overheats, the temperature sensor is actuated and the drive unit trips. The FIN signal can be output when the temperature becomes approximately 85% of the heatsink overheat protection operation temperature. For the terminal used for the FIN signal output, assign the function by setting "26 (positive logic) or 126 (negative logic)" in any of *Pr.190 to Pr.192 (output terminal function selection)*. *(Refer to page 144)*			
Check point	• Check for too high surrounding air temperature. • Check for heatsink clogging.			
Corrective action	• Set the surrounding air temperature to within the specifications. • Clean the heatsink.			

Operation panel indication	E.ILF		FR-PU07	Input phase loss
Name	Input phase loss			
Description	Drive unit trips when function valid setting (=1) is selected in *Pr.872 Input phase loss protection selection* and one phase of the three phase power input is lost. *(Refer to page 166)* It may be available if phase-to-phase voltage of the three-phase power input becomes largely unbalanced. When the setting of *Pr.872 Input phase loss protection selection* is the initial value (*Pr.872* = "0"), this warning does not occur.			
Check point	• Check for a break in the cable for the three-phase power supply input. • Check that phase-to-phase voltage of the three-phase power input is not largely unbalanced.			
Corrective action	• Wire the cables properly. • Repair a break portion in the cable. • Check the *Pr.872 Input phase loss protection selection* setting. • Set *Pr.872* = "0" (without input phase loss protection) when three-phase input voltage is largely unbalanced.			

Operation panel indication	E.OLT		FR-PU07	Stll Prev STP
Name	Stop by the torque limit			
Description	If the rotation speed drops to 18r/min or lower due to the torque limit operation and stays there for 3s, the fault indication (E.OLT) appears, and the drive unit outputs are shut off. OL appears during the torque limit operation. E.OLT may not occur if torque limit (OL) is activated during output phase loss.			
Check point	• Any of the acceleration time set by *Pr.7 Acceleration time*, deceleration time set by *Pr.8 Deceleration time*, and positioning acceleration/deceleration time set by *Pr.578 to Pr.591* is too short. • Check for torque shortage in a low-speed range. • Check if the acceleration/deceleration time in a low-speed range is too short. • Check that the load is not too heavy. • Are there any failure in peripheral devices? • Check that the *Pr.22 Torque limit level* is appropriate			
Corrective action	• Set a larger value in *Pr.7 Acceleration time*, *Pr.8 Deceleration time*, and positioning acceleration/deceleration time set in *Pr.578 to Pr.591*. *(Refer to page 125)* • Set a larger value in *Pr.785 PM control torque boost*. *(Refer to page 114)* S-PM • Set longer times in *Pr.791 Acceleration time in low-speed range* and *Pr.792 Deceleration time in low-speed range*. *(Refer to page 125)* • Reduce the load weight. • Set the torque limit operation current in *Pr.22 Torque limit level*. (The initial value differs according to the drive unit capacity and the motor being used.) Acceleration/deceleration time may change. Increase the torque limit operation level with *Pr.22 Torque limit level*, or disable the torque limit operation with *Pr.156 Torque limit selection*. (Operation at OL occurrence can be selected using *Pr.156*.) • Check the connection of the PM motor.			

Operation panel indication	E.SOT		FR-PU07	Motor step out
Name	Loss of synchronism detection			
Description	Stops the output when the operation is not synchronized.			
Check point	• Check that the PM motor is not driven overloaded. • Check if a start command is given to the drive unit while the PM motor is coasting. • Check if a motor other than the PM motor (MM-GKR motor, S-PM geared motor) is driven. • Check that the operation is performed with a motor connected.			
Corrective action	• Set the acceleration time longer. • Reduce the load. • Input a start command after the motor stops. • Drive the PM motor (MM-GKR motor, S-PM geared motor). • Check the connection of the PM motor. Set the PM motor test operation. *(Refer to page 75)*			

Operation panel indication	E.BE		FR-PU07	Br. Cct. Fault
Name	Brake transistor alarm detection			
Description	When a brake transistor alarm has occurred due to the large regenerative energy from the motor etc., the brake transistor alarm is detected and the drive unit trips. In this case, the drive unit must be powered OFF immediately.			
Check point	• Reduce the load inertia. • Check that the speed of using the brake is proper. • Check that the brake resistor selected is correct.			
Corrective action	Replace the drive unit.			

Operation panel indication	E.GF		FR-PU07	Ground Fault
Name	Output side earth (ground) fault overcurrent			
Description	The drive unit trips if an earth (ground) fault overcurrent flows at start due to an earth (ground) fault that occurred on the drive unit's output side (load side). Whether this protective function is used or not is set with *Pr.249 Earth (ground) fault detection at start*. When the setting of *Pr.249 Earth (ground) fault detection at start* is the initial value (*Pr.249* ="0"), this warning does not occur.			
Check point	Check for a ground fault in the motor and connection cable.			
Corrective action	Remedy the ground fault portion.			

Operation panel indication	E.LF		FR-PU07	E.LF
Name	Output phase loss			
Description	If one of the three phases (U, V, W) on the drive unit's output side (load side) is lost during drive unit operation (except during zero speed control and when the rotation speed is under 12r/min), drive unit stops the output. Whether the protective function is used or not is set with *Pr.251 Output phase loss protection selection*.			
Check point	• Check the wiring. (Check that the motor is normal.) • Check that the drive unit capacity matches with the motor capacity. • Check if a start command is given to the drive unit while the motor is coasting.			
Corrective action	• Wire the cables properly. • Choose drive unit and motor capacities that match. • Input a start command after the motor stops.			

Operation panel indication	E.OPT		FR-PU07	Option Fault
Name	Option fault			
Description	Appears when a communication option is connected while *Pr.296 Password lock level* = "0 or 100."			
Check point	Check if password lock is activated by setting *Pr.296 Password lock level* = "0, 100"			
Corrective action	• To apply the password lock when installing a communication option, set *Pr.296 Password lock level* ≠ "0, 100". *(Refer to page 183)* • If the problem still persists after taking the above measure, please contact your sales representative.			

Operation panel indication	E.OP1	E.OP 1	FR-PU07	Option slot alarm 1
Name	Communication option fault			
Description	Stops the drive unit output when a communication line fault occurs in the communication option.			
Check point	• Check for a wrong option function setting and operation. • Check that the plug-in option unit is plugged into the connector securely. • Check for a break in the communication cable. • Check that the terminating resistor is fitted properly.			
Corrective action	• Check the option function setting, etc. • Connect the plug-in option securely. • Check the connection of communication cable. • Connect the terminating resistor correctly.			

Operation panel indication	E.1	E. 1	FR-PU07	Fault 1
Name	Option fault			
Description	Stops the drive unit output if a contact fault or the like of the connector between the drive unit and communication option occurs. Appears when the switch for the manufacturer setting of the plug-in option is changed.			
Check point	• Check that the plug-in option unit is plugged into the connector securely. • Check for excess electrical noises around the drive unit. • Check the switch position for the manufacturer setting of the plug-in option.			
Corrective action	• Connect the plug-in option securely. • Take measures against noises if there are devices producing excess electrical noises around the drive unit. If the problem still persists after taking the above measure, please contact your sales representative. • Return the switch position for the manufacturer setting of the plug-in option to the initial status. *(Refer to the instruction manual of each option)*			

Operation panel indication	E.OHT	E.OHT	FR-PU07	OH Fault
Name	External thermal relay operation			
Description	If the external thermal relay provided for motor overheat protection or an internally provided thermal relay in the motor, etc. switches ON (contacts open), the drive unit outputs are stopped. This function is available when "7" (OH signal) is set to any of *Pr.178 to Pr.184 (input terminal function selection)*. This protective function is not available in the initial status (OH signal is not assigned).			
Check point	• Check for motor overheating. • Check that the value of 7 (OH signal) is set correctly in any of *Pr.178 to Pr.184 (input terminal function selection)*.			
Corrective action	• Reduce the load and speed of operation. • Even if the relay contacts are reset automatically, the drive unit will not restart unless it is reset.			

Operation panel indication	E.PE	E. PE	FR-PU07	Corrupt Memry
Name	Parameter storage device fault (control circuit board)			
Description	Stops the drive unit output if fault occurred in the parameter stored. (EEPROM fault)			
Check point	Check for too many number of parameter write times.			
Corrective action	Please contact your sales representative. When performing parameter write frequently for communication purposes, set "1" in *Pr.342* to enable RAM write. Note that powering OFF returns the drive unit to the status before RAM write.			

Operation panel indication	E.PE2	E.PE2	FR-PU07	PR storage alarm
Name	Internal board fault			
Description	When a combination of control board and main circuit board is wrong, the drive unit is tripped.			
Check point	————			
Corrective action	Please contact your sales representative. (For parts replacement, consult the nearest Mitsubishi FA Center.)			

Operation panel indication	**E.PUE**		**FR-PU07**	**PU Leave Out**
Name	PU disconnection			
Description	• This function stops the drive unit output if communication between the drive unit and PU is suspended, e.g. the parameter unit is disconnected, when "2", "3", "16" or "17" was set in *Pr.75 Reset selection/disconnected PU detection/PU stop selection*. • This function stops the drive unit output when communication errors occurred consecutively for more than permissible number of retries when a value other than "9999" is set in *Pr.121 Number of PU communication retries* during the RS-485 communication with the PU connector (use *Pr.502 Stop mode selection at communication error* to change). • This function also stops the drive unit output if communication is broken within the period of time set in *Pr.122 PU communication check time interval* during the RS-485 communication with the PU connector.			
Check point	• Check that the parameter unit (FR-PU07) is connected properly. • Check the *Pr.75* setting. • Check that RS-485 communication data is correct. And check that the settings of communication parameter at drive unit match settings of the computer. • Check that data is transmitted from the computer within a time set in *Pr.122 PU communication check time interval*.			
Corrective action	• Connect the parameter unit (FR-PU07) securely. • Check the communication data and communication settings. • Increase the *Pr.122 PU communication check time interval* setting. Or set "9999" (no communication check).			

Operation panel indication	**E.RET**		**FR-PU07**	**Retry No Over**
Name	Retry count excess			
Description	If operation cannot be resumed properly within the number of retries set, this function trips the drive unit. This function is available only when *Pr.67 Number of retries at fault occurrence* is set. When the initial value (*Pr.67* = "0") is set, this protective function is not available.			
Check point	Find the cause of fault occurrence.			
Corrective action	Eliminate the cause of the error preceding this error indication.			

Operation panel indication	**E. 5**		**FR-PU07**	**Fault 5**
	E. 6			**Fault 6**
	E. 7			**Fault 7**
	E.CPU			**CPU Fault**
Name	CPU fault			
Description	Stops the drive unit output if the communication fault of the built-in CPU occurs.			
Check point	• Check for devices producing excess electrical noises around the drive unit. • Check if the terminal PC is shorted with the terminal SD. (E. 6/E. 7)			
Corrective action	• Take measures against noises if there are devices producing excess electrical noises around the drive unit. • Check the connection between the terminals PC and SD. (E. 6/E. 7) • Please contact your sales representative.			

Operation panel indication	**E.IOH**		**FR-PU07**	**Inrush overheat**
Name	Inrush current limit circuit fault			
Description	Stops the drive unit output when the resistor of inrush current limit circuit overheated. The inrush current limit circuit fault			
Check point	Check that frequent power ON/OFF is not repeated.			
Corrective action	Configure a circuit where frequent power ON/OFF is not repeated. If the problem still persists after taking the above measure, please contact your sales representative.			

Operation panel indication	**E.AIE**		**FR-PU07**	**Analog in error**
Name	Analog input fault			
Description	Appears if voltage(current) is input to terminal 4 when the setting in *Pr.267 Terminal 4 input selection* and the setting of voltage/current input switch are different.			
Check point	Check the setting of *Pr.267 Terminal 4 input selection* and voltage/current input switch. *(Refer to page 168)*			
Corrective action	Either give a speed command by current input or set *Pr.267 Terminal 4 input selection*, and voltage/current input switch to voltage input.			

Operation panel indication	E.OS	E. OS	FR-PU07	E.OS
Name	Overspeed occurrence			
Description	Trips the drive unit if the motor speed exceeds *Pr.374 Overspeed detection level*.			
Check point	• Check that *Pr.374 Overspeed detection level* is appropriate. • Check if the three-phase (U, V, and W) wiring on the output side (load side) of the drive unit is correct. (Check for phase loss.) • Check for the rapid acceleration/deceleration.			
Corrective action	• Set *Pr.374 Overspeed detection level* appropriately. • Wire the cables properly. • Set the acceleration time longer. Set the speed control gain higher. Apply model adaptive speed control.			

Operation panel indication	E.OSD	E.OSd	FR-PU07	E.OSd
Name	Speed deviation excess detection			
Description	When *Pr.285 Excessive speed deviation detection speed* is set, this function stops the drive unit output if the motor speed is increased or decreased under the influence of the load etc. and cannot be controlled in accordance with the speed command value. This protective function is not available in the initial status.			
Check point	• Check if *Pr.285 Excessive speed deviation detection speed* and *Pr.853 Speed deviation time* are correctly set. • Check for sudden load change.			
Corrective action	• Set *Pr.285 Excessive speed deviation detection speed* and *Pr.853 Speed deviation time* correctly . • Keep the load stable.			

Operation panel indication	E.OD	E. Od	FR-PU07	E.Od
Name	Excessive position fault			
Description	Stops the output when the difference between the position command and the current position has exceeded the setting of *Pr.427 Excessive level error* under position control.			
Check point	• Check for large load. • Check that *Pr.427 Excessive level error* is appropriate.			
Corrective action	• Reduce the load. • Set *Pr.427 Excessive level error* appropriately.			

Operation panel indication	E.OA	E. OA	FR-PU07	Fault
Name	Acceleration error			
Description	Stops the output when the acceleration rate of the motor rotation speed has exceeded the setting of *Pr.375 Faulty acceleration rate detection level*.			
Check point	• Check for sudden load change. • Check that *Pr.375 Faulty acceleration rate detection level* is appropriate. • Check that the setting of the acceleration/deceleration rate is large.			
Corrective action	• Reduce the load. • Set *Pr.375 Faulty acceleration rate detection level* appropriately. • If the acceleration/deceleration rate is large and the error occurs even in normal operation, set *Pr.375* ="9999 (detecting the error disabled)".			

Operation panel indication	E.USB	E.USb	FR-PU07	USB comm error
Name	USB communication fault			
Description	When communication has broken during the time set in *Pr.548 USB communication check time interval*, this function stops the drive unit output.			
Check point	• Check the USB communication cable.			
Corrective action	• Check the *Pr.548 USB communication check time interval* setting. • Check the USB communication cable. • Increase the *Pr.548 USB communication check time interval* setting. Or, change the setting to 9999.			

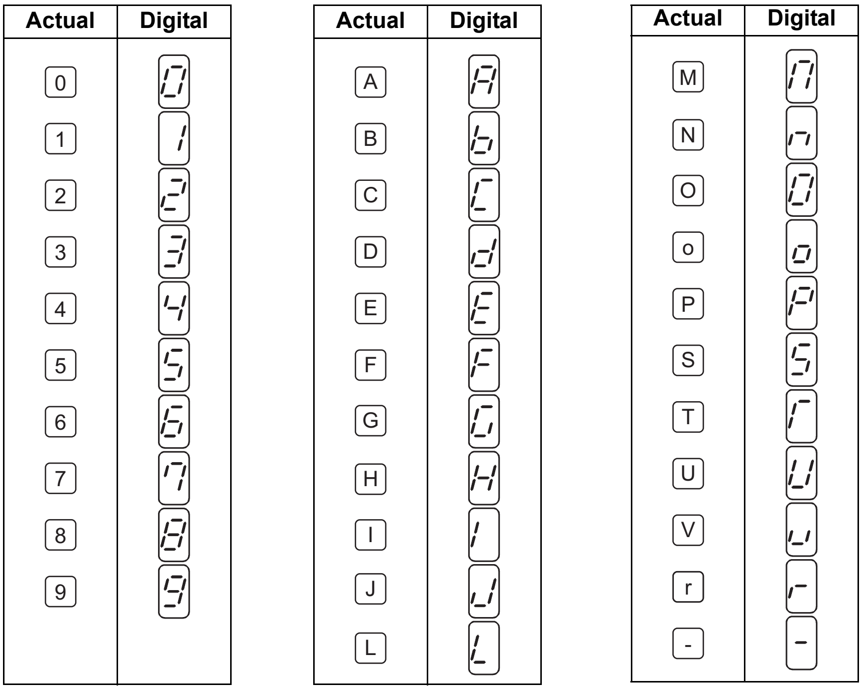
Operation panel indication	E.SAF	E.SAF	FR-PU07	Fault E.SAF
	E.13	E. 13	FR-PU07	Fault 13
Name	Safety circuit fault			
Description	Stop the drive unit output when an internal circuit fault occurred.			
Corrective action	Please contact your sales representative.			

NOTE

- **If faults other than the above appear, contact your sales representative.**

5.4 Correspondences between digital and actual characters

There are the following correspondences between the actual alphanumeric characters and the digital characters displayed on the operation panel:



5.5 Check first when you have a trouble

POINT

- If the cause is still unknown after every check, it is recommended to initialize the parameters (initial value) then set the required parameter values and check again.

5.5.1 *Motor does not start*

Check Points	Possible Cause	Countermeasures	Refer to page
Main Circuit	Appropriate power supply voltage is not applied. (Operation panel display is not provided.)	Power ON moulded case circuit breaker (MCCB), an earth leakage circuit breaker (ELB), or a magnetic contactor (MC).	—
		Check for the decreased input voltage, input phase loss, and wiring.	
	Motor is not connected properly.	Check the wiring between the drive unit and the motor.	*15*
	The jumper across P/+ to P1 is disconnected.	Securely fit a jumper across P/+ to P1. To use a DC reactor (FR-HEL) or Filterpack, remove the jumper across the terminals P/+ and P1, then connect the DC reactor or Filterpack.	*32*
Input Signal	Start signal is not input.	Check the start command source, and input a start signal. PU operation mode: RUN External operation mode : STF/STR signal	*188*
	Both the forward and reverse rotation start signals (STF, STR) are input simultaneously.	Turn ON only one of the forward and reverse rotation start signals (STF or STR). If the STF and STR signals are turned ON simultaneously in the initial setting, a stop command is given.	*168*
	Speed command is zero.	Check the speed command source and enter a speed command.	*188*
	AU signal is not ON when terminal 4 is used for speed setting.	Turn ON the AU signal. Turning ON the AU signal activates terminal 4 input.	*168*
	Output stop signal (MRS) or reset signal (RES) is ON. (RUN LED on the operation panel flickers while MRS signal is ON.)	Turn MRS or RES signal OFF. Drive unit starts the operation with a given start command and a speed command after turning OFF MRS or RES signal. Before turning OFF, ensure the safety.	*18*
	Jumper connector of sink - source is wrongly selected.	Check that the control logic switchover jumper connector is correctly installed. If it is not installed correctly, input signal is not recognized.	*21*
	Voltage/current input switch is not correctly set for analog input signal (0 to 5V/0 to 10V, 4 to 20mA).	Set *Pr.73, Pr.267*, and a voltage/current input switch correctly, then input an analog signal in accordance with the setting.	*18*
	STOP RESET was pressed. (Operation panel indication is PS (PS).)	During the External operation mode, check the method of restarting from a STOP RESET input stop from PU.	*270*
	Two-wire or three-wire type connection is wrong.	Check the connection. Connect STOP signal when three-wire type is used.	*142*
	Servo-ON signal (SON) is assigned, but is not input.	Turn ON the SON signal.	*131*
	Under position control, servo-ON signal (SON) or pre-excitation signal (LX) is not input.	Assign the SON signal or the LX signal to an input terminal, and turn ON the signal.	*131*
	Under position control, position control sudden stop signal (X87) is input.	Turn OFF the X87 signal. Check the *Pr.535 Position control terminal input selection* setting.	*100*

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Under position control, the forward rotation stroke end (LSP) or the reverse rotation stroke end (LSN) signal is assigned, but is not input.	Turn ON the LSP or LSN signal. Check the *Pr.535 Position control terminal input selection* setting.	*100*
Parameter Setting	*Pr.78 Reverse rotation prevention selection* is set.	Check the *Pr.78* setting. Set *Pr.78* when you want to limit the motor rotation to only one direction.	*182*
	Pr.79 Operation mode selection setting is wrong.	Select the operation mode which corresponds with input methods of start command and speed command.	*188*
	Bias and gain *(calibration parameter C2 to C7)* settings are improper.	Check the bias and gain *(calibration parameter C2 to C7)* settings.	*173*
Parameter Setting	*Pr.13 Starting speed* setting is greater than the running speed.	Set running speed higher than *Pr.13*. The drive unit does not start if the speed setting signal is less than the value set in *Pr.13*.	*128*
	Speed settings of various running speed (such as multispeed operation) are zero. Especially, *Pr.1 Maximum setting* is zero.	Set the speed command according to the application. Set *Pr.1* higher than the actual speed used.	*115*
	Pr.15 Jog speed setting is lower than *Pr.13 Starting speed.*	Set *Pr.15 Jog speed setting* higher than *Pr.13 Starting speed.*	*119*
	Operation mode and a writing device do not match.	Check *Pr.79, Pr.338, Pr.339, Pr.551*, and select an operation mode suitable for the purpose.	*186, 195*
	Start signal operation selection is set by the *Pr.250 Stop selection.*	Check *Pr.250* setting and connection of STF and STR signals.	*142*
	PM motor test operation is selected.	Set "10" in *Pr.800 Control method selection.*	*75*
Load	Load is too heavy.	Reduce the load.	—
	Shaft is locked.	Inspect the machine (motor).	—
Others	Operation panel display shows an error (e.g. E.OC1).	When any fault occurs, take an appropriate corrective action, then reset the drive unit, and resume the operation.	*267*
	Under position control, point table position control based on the absolute position does not operate.	Perform home position return.	*95, 104*

5.5.2 Motor or machine is making abnormal acoustic noise

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Disturbance due to EMI when speed command is given from analog input (terminal 2, 4).	Take countermeasures against EMI.	*36*
Parameter Setting		Increase the *Pr.74 Input filter time constant* if steady operation cannot be performed due to EMI.	*172*
Parameter Setting	Resonance occurs. (rotation speed)	Set *Pr.31 to Pr.36 (speed jump)*. When it is desired to avoid resonance attributable to the natural speed of a mechanical system, these parameters allow resonant speeds to be jumped. Set *Pr.862, Pr.863, and Pr.871 (notch filter)*.	*85, 116*
	Gain adjustment during PID control is insufficient.	To stabilize the measured value, change the proportional band (*Pr.129*) to a larger value, the integral time (*Pr.130*) to a slightly longer time, and the differential time (*Pr.134*) to a slightly shorter time. Check the calibration of set point and measured value.	*235*
	Speed control gain is too high.	Check *Pr.820 Speed control P gain* setting.	*80*
	Under position control, position control gain is too high.	Check the *Pr.422 Position control gain* setting.	*92*
Others	Mechanical looseness	Adjust machine/equipment so that there is no mechanical looseness.	—
Motor	Operating with output phase loss	Check the motor wiring.	—
	High-frequency tone is heard while the motor is at a stop.	High-frequency tone may be generated during the MM-GKR motor driving operation because high frequency currents are superposed during low-speed operation and stopping. This is a normal operation.	—
	Please contact your sales representative.		

5.5.3 Motor generates heat abnormally

Check Points	Possible Cause	Countermeasures	Refer to page
Motor	The required space is not provided around the motor.	Improve the environment around the motor.	—
	The mounting flange is small.	Use a bigger flange.	—
Main Circuit	The drive unit output voltage (U, V, W) are unbalanced.	Check the output voltage of the drive unit. Check the insulation of the motor.	289
—	Motor current is large.	Refer to "5.5.10 Motor current is too large"	284

5.5.4 Motor rotates in the opposite direction

Check Points	Possible Cause	Countermeasures	Refer to page
Main Circuit	Phase sequence of output terminals U, V and W is incorrect.	Connect phase sequence of the output cables (terminal U, V, W) to the motor correctly	15
	The rotation direction of the output shaft is changed by the reduction gear.	Check the rotation direction of the motor's output shaft.	15
Input Signal	The start signals (forward rotation, reverse rotation) are connected improperly.	Check the wiring. (STF: forward rotation, STR: reverse rotation)	18
	Adjustment by the rotation speed is improper during the reversible operation with *Pr.73 Analog input selection* setting.	Check the setting of *Pr.125, Pr.126, C2 to C7*.	173
Parameter Setting	*Pr.40 RUN key rotation direction selection* setting is incorrect.	Check the *Pr.40* setting.	255
	Under position control, the sign of the position command is incorrect.	Check the sign setting of positioning sub-function in *Pr.525 to Pr.531*.	95
	Under position control, the *Pr.463 Position control rotation direction selection* setting is incorrect.	Check the *Pr.463* setting.	92

5.5.5 Speed greatly differs from the setting

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Speed setting signal is incorrectly input.	Measure the input signal level.	—
	The input signal lines are affected by external EMI.	Take countermeasures against EMI such as using shielded wires for input signal lines.	36
Parameter Setting	*Pr.1, Pr.2, calibration parameter C2 to C7* settings are improper.	Check the settings of *Pr.1 Maximum setting*, *Pr.2 Minimum setting*.	115
		Check the *calibration parameter C2 to C7* settings.	173
	Pr.31 to Pr.36 (speed jump) settings are improper.	Narrow down the range of speed jump.	116
	Under position control, the maximum speed setting is incorrect in *Pr.4 to Pr.6*, and *Pr.24 to Pr.27*.	Check the maximum speed setting in *Pr.4 to Pr.6*, and *Pr.24 to Pr.27*.	95
Load	Torque limit function is activated due to a heavy load.	Reduce the load weight.	—
Parameter Setting		Set *Pr.22 Torque limit level* higher according to the load. (Setting *Pr.22* too large may result in frequent overcurrent trip (E.OC□).)	111
Motor		Check the capacities of the drive unit and the motor.	—

5.5.6 Acceleration/deceleration is not smooth

Check Points	Possible Cause	Countermeasures	Refer to page
Parameter Setting	Torque limit function is activated due to a heavy load.	Reduce the load weight.	—
		Set *Pr.22 Torque limit level* higher according to the load. (Setting *Pr.22* too large may result in frequent overcurrent trip (E.OC□).)	*111*
		Check the capacities of the drive unit and the motor.	—
	Acceleration/deceleration time is too short.	Increase acceleration/deceleration time.	*125*
	Regeneration avoidance operation is performed	If the speed becomes unstable during regeneration avoidance operation, decrease the setting of *Pr.886 Regeneration avoidance voltage gain*.	*242*
	Pr.791 and Pr.792 (Acceleration/deceleration time in low-speed range) are set.	Check the *Pr.791 and Pr.792 (Acceleration/deceleration time in low-speed range)* settings.	*125*
	When any mechanical looseness or load fluctuation exists, the motor resistance calculated by the drive unit is inaccurate.	Set the wiring resistance value in *Pr.658 Wiring resistance*.	*87*
Others	Mechanical looseness or load fluctuation	Adjust machine/equipment so that there is no mechanical looseness. Eliminate the load fluctuation. Use *Pr.156 Torque limit selection* to disable the torque limit.	*111*

5.5.7 Speed varies during operation

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	The speed setting signal is affected by EMI.	Set filter to the analog input terminal using *Pr.74 Input filter time constant*.	*172*
		Take countermeasures against EMI, such as using shielded wires for input signal lines.	*36*
	Malfunction is occurring due to the undesirable current generated when the transistor output unit is connected.	Use terminal PC (terminal SD when source logic) as a common terminal to prevent a malfunction caused by undesirable current.	*21*
	Multi-speed command signal is chattering.	Take countermeasures to suppress chattering.	—
Parameter Setting	Hunting occurs by the generated vibration, for example, when structural rigidity at load side is insufficient.	Disable automatic control functions, such as regeneration avoidance function and torque limit operation. During the PID control, set smaller values to *Pr.129 PID proportional band* and *Pr.130 PID integral time*. Lower the control gain, and adjust to increase the stability.	—

5.5.8 Operation mode is not changed properly

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Start signal (STF or STR) is ON.	Check that the STF and STR signals are OFF. When either is ON, the operation mode cannot be changed.	186
Parameter Setting	*Pr.79* setting is improper.	When *Pr.79 Operation mode selection* setting is "0" (initial value), the drive unit is placed in the External operation mode at input power ON. To switch to the PU operation mode, press PU/EXT on the operation panel (press PU when the parameter unit (FR-PU07) is used). At other settings (1 to 4, 6, 7), the operation mode is limited accordingly.	186
	Operation mode and a writing device do not correspond.	Check *Pr.79, Pr.338, Pr.339, Pr.551*, and select an operation mode suitable for the purpose.	186, 195

5.5.9 Operation panel display is not operating

Check Points	Possible Cause	Countermeasures	Refer to page
Main Circuit	Wiring or installation is improper.	Check for the wiring and the installation.	14
		Make sure that the connector is fitted securely across terminal P/+ to P1.	
Main Circuit Control Circuit	Power is not input.	Input the power.	14
Parameter Setting	Command sources at the PU operation mode is not at the operation panel. (None of the operation mode displays (PU EXT NET) is lit.)	Check the setting of *Pr.551 PU mode operation command source selection*. (If parameter unit (FR-PU07) is connected while *Pr.551* = "9999" (initial setting), all the operation mode displays (PU EXT NET) turn OFF.)	195

5.5.10 Motor current is too large

Check Points	Possible Cause	Countermeasures	Refer to page
Parameter Setting	Torque limit function is activated due to a heavy load.	Reduce the load weight.	—
		Set *Pr.22 Torque limit level* higher according to the load. (Setting *Pr.22* too large may result in frequent overcurrent trip (E.OC□).)	111
		Check the capacities of the drive unit and the motor.	—

5.5.11 Speed does not accelerate

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Start command and speed command are chattering.	Check if the start command and the speed command are correct.	—
	The wiring length used for analog speed command is too long, and it is causing a voltage (current) drop.	Perform analog input bias/gain calibration.	*173*
	Input signal lines are affected by external EMI.	Take countermeasures against EMI, such as using shielded wires for input signal lines.	*36*
Parameter Setting	*Pr.1, Pr.2, calibration parameter C2 to C7* settings are improper.	Check the settings of *Pr.1 Maximum setting* and *Pr.2 Minimum setting*.	*115*
		Check the *calibration parameter C2 to C7* settings.	*173*
		The maximum speed is limited to the maximum speed of the PM motor (3000r/min).	*307*
	The maximum voltage (current) input value is not set during the External operation. *(Pr.125, Pr.126)*	Check the *Pr.125 Terminal 2 speed setting gain speed* and *Pr.126 Terminal 4 speed setting gain speed* settings.	*115, 173*
	Torque limit function is activated due to a heavy load.	Reduce the load weight.	—
		Set *Pr.22 Torque limit level* higher according to the load. (Setting *Pr.22* too large may result in frequent overcurrent trip (E.OC□).)	*111*
		Check the capacities of the drive unit and the motor.	—
	During PID control, rotation speed is automatically controlled to make measured value = set point.		*235*
Main Circuit	Brake resistor is connected between terminal P/+ and P1 or between terminal P1 and PR by mistake.	Connect an optional brake transistor (MRS type, FR-ABR) between terminal P/+ and PR.	*27*

5.5.12 Unable to write parameter setting

Check Points	Possible Cause	Countermeasures	Refer to page
Input Signal	Operation is being performed (signal STF or STR is ON).	Stop the operation. When *Pr.77* = "0" (initial value), write is enabled only during a stop.	*181*
Parameter Setting	You are attempting to set the parameter in the External operation mode.	Choose the PU operation mode. Or, set *Pr.77* = "2" to enable parameter write regardless of the operation mode.	*181*
	Parameter is disabled by the *Pr.77 Parameter write selection* setting.	Check *Pr.77 Parameter write selection* setting.	*181*
	Key lock is activated by the *Pr.161 Speed setting/key lock operation selection* setting.	Check *Pr.161 Speed setting/key lock operation selection* setting.	*256*
	Operation mode and a writing device do not correspond.	Check *Pr.79, Pr.338, Pr.339, Pr.551*, and select an operation mode suitable for the purpose.	*186, 195*

MEMO

6 PRECAUTIONS FOR MAINTENANCE AND INSPECTION

This chapter provides the "PRECAUTIONS FOR MAINTENANCE AND INSPECTION" of this product.
Always read the instructions before using the equipment.

The drive unit is a static unit mainly consisting of semiconductor devices. Daily inspection must be performed to prevent any fault from occurring due to the adverse effects of the operating environment, such as temperature, humidity, dust, dirt and vibration, changes in the parts with time, service life, and other factors.

●Precautions for maintenance and inspection

For some short time after the power is switched OFF, a high voltage remains in the smoothing capacitor. When accessing the drive unit for inspection, wait for at least 10 minutes after the power supply has been switched OFF, and then make sure that the voltage across the main circuit terminals P/+ and N/- of the drive unit is not more than 30VDC using a tester, etc.
If "EV" is displayed on the operation panel with FR-E7DS mounted, turn off the 24V external power supply before an inspection. *(Refer to page 316)*

6.1 Inspection items

6.1.1 Daily inspection

Basically, check for the following faults during operation.
(1) Motor operation fault
(2) Improper installation environment
(3) Cooling system fault
(4) Abnormal vibration, abnormal noise
(5) Abnormal overheat, discoloration

6.1.2 Periodic inspection

Check the areas inaccessible during operation and requiring periodic inspection.
For a periodic inspection, contact your sales representative.
(1) Check for cooling system fault............Clean the air filter, etc.
(2) Tightening check and retightening......The screws and bolts may become loose due to vibration, temperature changes, etc. Check and tighten them.
Tighten them according to the specified tightening torque *(Refer to page 16, 23)*
(3) Check the conductors and insulating materials for corrosion and damage.
(4) Measure insulation resistance.
(5) Check and change the cooling fan and the relay.

6.1.3 Daily and periodic inspection

Area of Inspection	Inspection Item		Description	Interval: Daily	Interval: Periodic *2	Corrective Action at Alarm Occurrence	Customer's Check
General	Surrounding environment		Check the surrounding air temperature, humidity, dirt, corrosive gas, oil mist, etc.	○		Improve environment	
	Overall unit		Check for unusual vibration and noise.	○		Check alarm location and retighten	
			Check for dirt, oil, and other foreign material.*3	○		Clean	
	Power supply voltage		Check that the main circuit voltages are normal. *1	○		Inspect the power supply	
Main circuit	General		(1) Check with megger (across main circuit terminals and earth (ground) terminal).		○	Contact the manufacturer	
			(2) Check for loose screws and bolts.		○	Retighten	
			(3) Check for overheat traces on parts.		○	Contact the manufacturer	
			(4) Check for stains.		○	Clean	
	Conductors, cables		(1) Check conductors for distortion.		○	Contact the manufacturer	
			(2) Check cable sheaths for breakage and deterioration (crack, discoloration, etc.).		○	Contact the manufacturer	
	Terminal block		Check for damage.		○	Stop the device and contact the manufacturer.	
	Smoothing aluminum electrolytic capacitor		(1) Check for liquid leakage.		○	Contact the manufacturer	
			(2) Check for safety valve projection and bulge.		○	Contact the manufacturer	
			(3) Visual check and judge by the life check of the main circuit capacitor *(Refer to page 290)*		○		
	Relay		Check that the operation is normal and no chatter is heard.		○	Contact the manufacturer	
Control circuit, Protective circuit	Operation check		(1) Check that the output voltages across phases with the drive unit operated alone is balanced.		○	Contact the manufacturer	
			(2) Check that no fault is found in protective and display circuits in a sequence protective operation test.		○	Contact the manufacturer	
	Parts check	Overall	(1) Check for unusual odors and discoloration.		○	Stop the device and contact the manufacturer.	
			(2) Check for serious rust development.		○	Contact the manufacturer	
		Aluminum electrolytic capacitor	(1) Check for liquid leakage in a capacitor and deformation trace.		○	Contact the manufacturer	
			(2) Visual check and judge by the life check of the main circuit capacitor *(Refer to page 290)*		○		
Cooling system	Cooling fan		(1) Check for unusual vibration and noise.	○		Replace the fan	
			(2) Check for loose screws and bolts		○	Fix with the fan cover fixing screws	
			(3) Check for stains		○	Clean	
	Heatsink		(1) Check for clogging.		○	Clean	
			(2) Check for stains.		○	Clean	
Display	Indication		(1) Check that display is normal.	○		Contact the manufacturer	
			(2) Check for stains.		○	Clean	
	Meter		Check that reading is normal.	○		Stop the device and contact the manufacturer.	
Load motor	Operation check		Check for vibration and abnormal increase in operation noise.	○		Stop the device and contact the manufacturer.	

*1 It is recommended to install a device to monitor voltage for checking the power supply voltage to the drive unit.
*2 One to two years of periodic inspection cycle is recommended. However, it differs according to the installation environment.
For a periodic inspection, contact your sales representative.
*3 The oil component of the heat dissipation grease used inside the drive unit may leak out. The oil component, however, is not flammable, corrosive, nor conductive and is not harmful to humans. Wipe off such an oil component with a cloth, etc.

NOTE

Continuous use of a leaked, deformed, or degraded smoothing aluminum electrolytic capacitor (as shown in the table above) may lead to a burst, breakage, or a fire. Replace such a capacitor without delay.

6.1.4 Display of the life of the drive unit parts

The self-diagnostic warning is output when the life span of each part such as the control circuit capacitor, the cooling fan, or the inrush current limit circuit is near its end. It gives an indication of replacement time.

The life alarm output can be used as a guideline for life judgement.

Parts	Judgement Level
Main circuit capacitor	85% of the initial capacity
Control circuit capacitor	Estimated remaining life 10%
Inrush current limit circuit	Estimated remaining life 10% (Power on: 100,000 times left)
Cooling fan	Less than 50% of the specified rotations per minute

POINT

Refer to page 245 to perform the life check of the drive unit parts.

6.1.5 Checking the drive unit and converter modules

<Preparation>

(1) Disconnect the external power supply cables (R/L1, S/L2, T/L3) and motor cables (U, V, W).

(2) Prepare a tester. (Use 100Ω range.)

<Checking method>

Change the polarity of the tester alternately at the drive unit terminals R/L1, S/L2, T/L3, U, V, W, P/+ and N/-, and check for electric continuity.

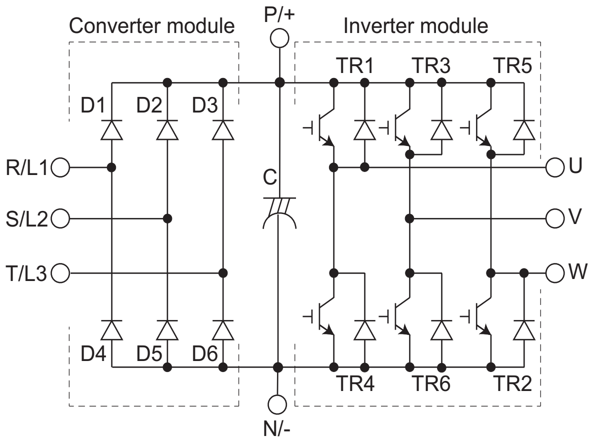
NOTE

- **Before measurement, check that the smoothing capacitor is discharged.**
- **At the time of electric discontinuity, the measured value is almost ∞. When there is an instantaneous electric continuity, due to the smoothing capacitor, the tester may not indicate ∞. At the time of continuity, the measured value is several to several tens-of ohms depending on the module type, circuit tester type, etc. If all measured values are almost the same, the modules are without fault.**

<Module device numbers and terminals to be checked>

		Tester Polarity		Measured Value		Tester Polarity		Measured Value
		⊕	⊖			⊕	⊖	
Converter module	D1	R/L1	P/+	Discontinuity	D4	R/L1	N/-	Continuity
		P/+	R/L1	Continuity		N/-	R/L1	Discontinuity
	D2	S/L2	P/+	Discontinuity	D5	S/L2	N/-	Continuity
		P/+	S/L2	Continuity		N/-	S/L2	Discontinuity
	D3	T/L3	P/+	Discontinuity	D6*	T/L3	N/-	Continuity
		P/+	T/L3	Continuity		N/-	T/L3	Discontinuity
Inverter module	TR1	U	P/+	Discontinuity	TR4	U	N/-	Continuity
		P/+	U	Continuity		N/-	U	Discontinuity
	TR3	V	P/+	Discontinuity	TR6	V	N/-	Continuity
		P/+	V	Continuity		N/-	V	Discontinuity
	TR5	W	P/+	Discontinuity	TR2	W	N/-	Continuity
		P/+	W	Continuity		N/-	W	Discontinuity

(Assumes the use of an analog meter.)



6.1.6 Cleaning

Always run the drive unit in a clean status.

When cleaning the drive unit, gently wipe dirty areas with a soft cloth immersed in neutral detergent or ethanol.

NOTE

- **Do not use solvent, such as acetone, benzene, toluene and alcohol, as they will cause the drive unit surface paint to peel off.**
  The display, etc. of the operation panel and parameter unit (FR-PU07) are vulnerable to detergent and alcohol. Therefore, avoid using them for cleaning.

6.1.7 Replacement of parts

The drive unit consists of many electronic parts such as semiconductor devices.

The following parts may deteriorate with age because of their structures or physical characteristics, leading to reduced performance or fault of the drive unit. For preventive maintenance, the parts must be replaced periodically.

Use the life check function as a guidance of parts replacement.

Part Name	Estimated lifespan *1	Description
Cooling fan	10 years	Replace (as required)
Main circuit smoothing capacitor	10 years *2	Replace (as required)
On-board smoothing capacitor	10 years *2	Replace the board (as required)
Relays	—	as required

*1 Estimated lifespan for when the yearly average surrounding air temperature is 40°C (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)

*2 Output current: 80% of the drive unit rated current

NOTE

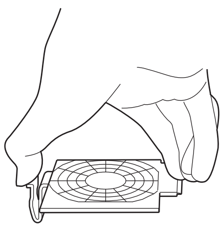
- **For parts replacement, consult the nearest Mitsubishi FA Center.**

(1) Cooling fan

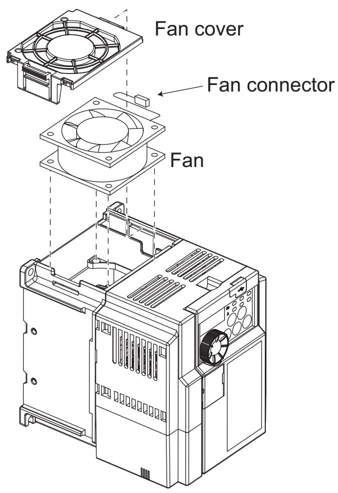
The replacement interval of the cooling fan used for cooling the parts generating heat such as the main circuit semiconductor is greatly affected by the surrounding air temperature. When unusual noise and/or vibration is noticed during inspection, the cooling fan must be replaced immediately.

●Removal

1) Push the hooks from above and remove the fan cover.

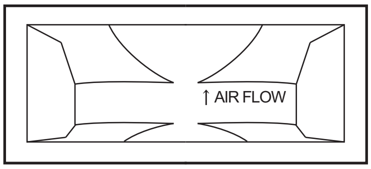


2) Disconnect the fan connectors.
3) Remove the fan.



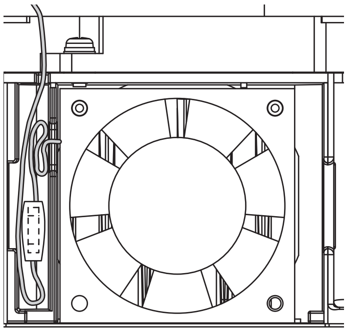
●Reinstallation

1) After confirming the orientation of the fan, reinstall the fan so that the arrow on the left of "AIR FLOW" faces up.

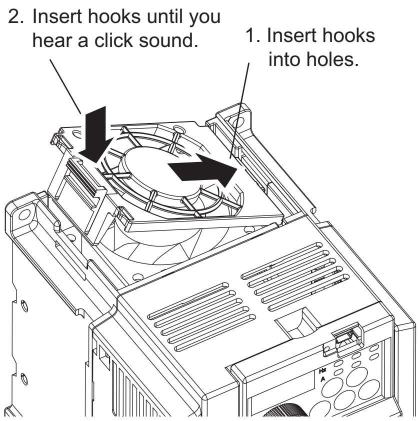


<Fan side face>

2) Reconnect the fan connectors.
3) When wiring, avoid the cables being caught by the fan.



4) Reinstall the fan cover.



NOTE

- **Installing the fan in the opposite of air flow direction can cause the drive unit life to be shorter.**
- **Prevent the cable from being caught when installing a fan.**
- **Switch the power OFF before replacing fans. Since the drive unit circuits are charged with voltage even after power OFF, replace fans only when the drive unit cover is on the drive unit to prevent an electric shock accident.**

(2) Smoothing capacitors

A large-capacity aluminum electrolytic capacitor is used for smoothing in the main circuit DC section, and an aluminum electrolytic capacitor is used for stabilizing the control power in the control circuit. Their characteristics are deteriorated by the adverse effects of ripple currents, etc. The replacement intervals greatly vary with the surrounding air temperature and operating conditions. When the drive unit is operated in air-conditioned, normal environment conditions, replace the capacitors about every 10 years.
When a certain period of time has elapsed, the capacitors will deteriorate more rapidly. Check the capacitors at least every year (less than six months if the life will be expired soon).
The appearance criteria for inspection are as follows:

1) Case: Check the side and bottom faces for expansion
2) Sealing plate: Check for remarkable warp and extreme crack.
3) Check for external crack, discoloration, liquid leakage, etc. Judge that the capacitor has reached its life when the measured capacitance of the capacitor reduced below 80% of the rating.

POINT

Refer to page 245 to perform the life check of the main circuit capacitor.

(3) Relays

To prevent a contact fault, etc., relays must be replaced according to the cumulative number of switching times (switching life).

6.1.8 Drive unit replacement

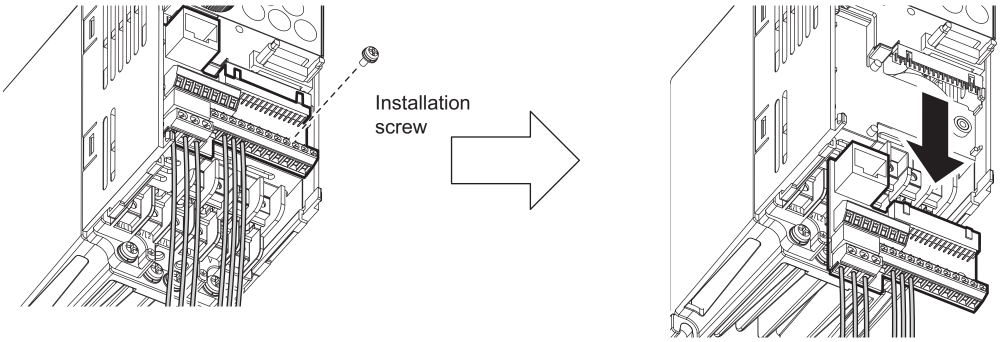
The drive unit can be replaced with the control circuit wiring kept connected. Before replacement, remove the wiring cover of the drive unit.

NOTE

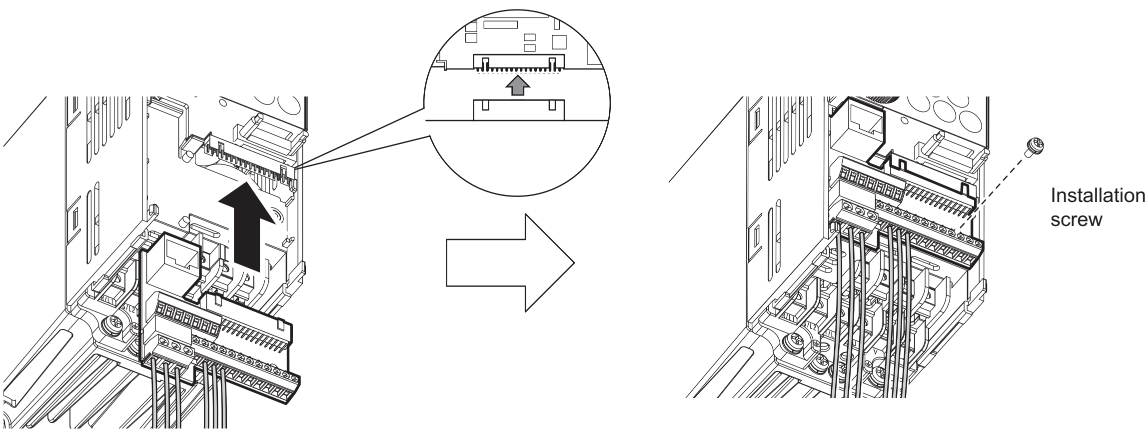
- **Before starting drive unit replacement, switch power OFF, wait for at least 10 minutes, and then check the voltage with a tester and such to ensure safety.**

● Replacement procedure (Example of FR-E720EX-0.75K)

(1) Remove the installation screw of the control circuit terminal block.
Pull the control circuit terminal downward.



(2) Using care not to bend the pins of the drive unit's control circuit connector, reinstall the control circuit terminal block and fix it with the installation screw.



6.2 Measurement of main circuit voltages, currents and powers

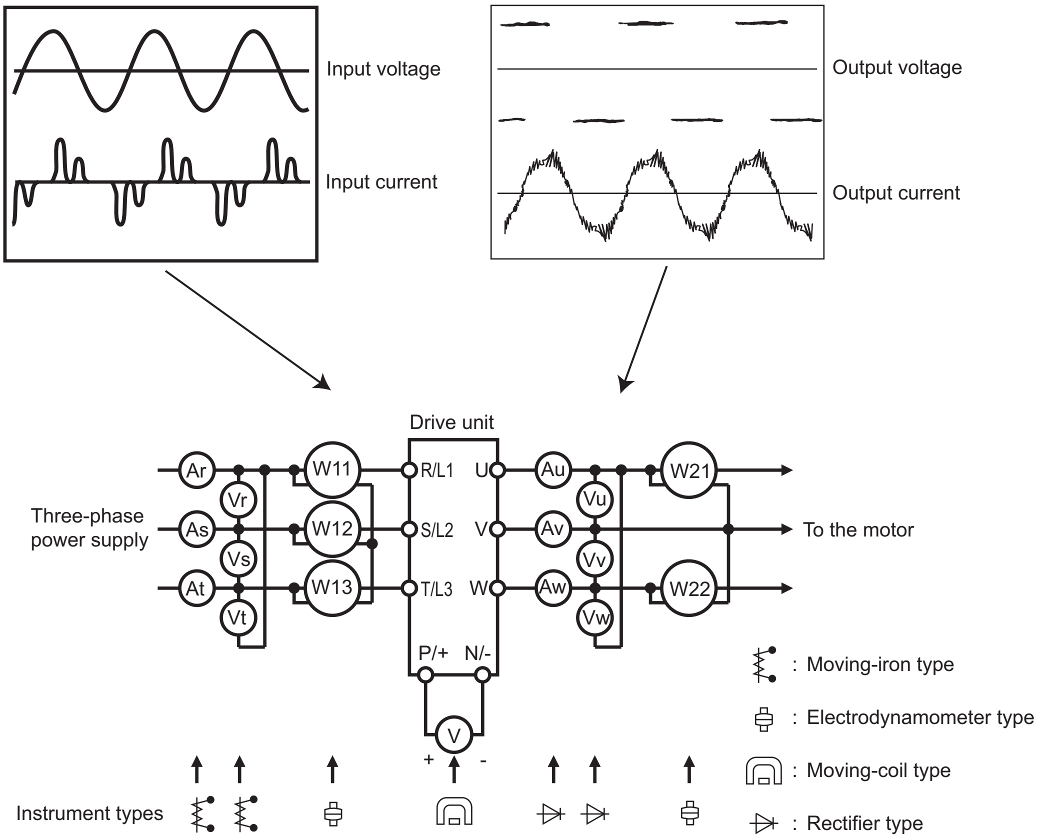
Since the voltages and currents on the drive unit power supply and output sides include harmonics, measurement data depends on the instruments used and circuits measured.

When instruments for commercial frequency are used for measurement, measure the following circuits with the instruments given on the next page.

- When installing meters etc. on the drive unit output side

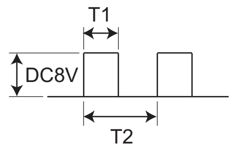
  When the drive unit-to-motor wiring length is large small-capacity models, the meters and CTs may generate heat due to line-to-line leakage current. Therefore, choose the equipment which has enough allowance for the current rating.

  To measure and display the output voltage and output current of the drive unit, it is recommended to use the FM-SD terminal output function of the drive unit.



Examples of Measuring Points and Instruments

Measuring Points and Instruments

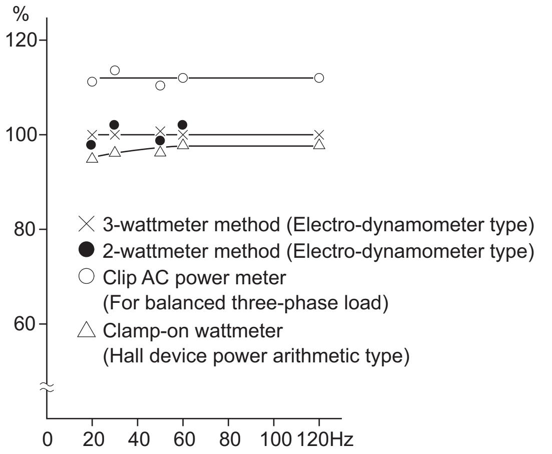
<table>
<tr><th>Item</th><th>Measuring Point</th><th>Measuring Instrument</th><th colspan="2">Remarks (Reference Measured Value)</th></tr>
<tr><td>Power supply voltage
V1</td><td>R/L1 and S/L2
S/L2 and T/L3
T/L3 and R/L1</td><td>Moving-iron type AC voltmeter *3</td><td colspan="2">Commercial power supply
Within permissible AC voltage fluctuation
(Refer to page 302)</td></tr>
<tr><td>Power supply side current
I1</td><td>R/L1, S/L2, T/L3 line current</td><td>Moving-iron type AC ammeter *3</td><td colspan="2"></td></tr>
<tr><td>Power supply side power
P1</td><td>R/L1, S/L2, T/L3 and R/L1 and S/L2,
S/L2 and T/L3,
T/L3 and R/L1</td><td>Digital power meter (designed for inverter) or electrodynamic type singlephase wattmeter</td><td colspan="2">P1=W11+W12+W13 (3-wattmeter method)</td></tr>
<tr><td>Power supply side power factor
Pf1</td><td colspan="4">Calculate after measuring power supply voltage, power supply side current and power supply side power.
[Three-phase power supply]
$Pf_1 = \dfrac{P_1}{\sqrt{3}V_1 \times I_1} \times 100\ \%$</td></tr>
<tr><td>Output side voltage
V2</td><td>Across U and V,
V and W,
W and U</td><td>Rectifier type AC voltage meter *1, *3
(moving-iron type cannot measure)</td><td colspan="2">Difference between the phases is within 1% of the maximum output voltage.</td></tr>
<tr><td>Output side current
I2</td><td>U, V and W line currents</td><td>Approximate effective-value rectifier type AC ammeter *3</td><td colspan="2">Difference between the phases is 10% or lower of the rated drive unit current.</td></tr>
<tr><td>Output side power
P2</td><td>U, V, W and
U and V,
V and W</td><td>Digital power meter (designed for inverter) or electrodynamic type singlephase wattmeter</td><td colspan="2">P2=W21+W22
2-wattmeter method (or 3-wattmeter method)</td></tr>
<tr><td>Output side power factor
Pf2</td><td colspan="4">Calculate in similar manner to power supply side power factor.
$Pf_2 = \dfrac{P_2}{\sqrt{3}V_2 \times I_2} \times 100\ \%$</td></tr>
<tr><td>Converter output</td><td>Across P/+ and N/-</td><td>Moving-coil type
(such as tester)</td><td colspan="2">Drive unit LED display is lit. 1.35 × V1
380V maximum during regeneration</td></tr>
<tr><td rowspan="2">Frequency setting signal</td><td>Across 2(+) and 5</td><td rowspan="7">Moving-coil type
(tester and such may be used)
(internal resistance 50kΩ or more)</td><td rowspan="2">DC0 to 10V, 4 to 20mA</td><td rowspan="3">"5" is common</td></tr>
<tr><td>Across 4(+) and 5</td></tr>
<tr><td>Frequency setting power supply</td><td>Across 10(+) and 5</td><td>DC5.2V</td></tr>
<tr><td>Frequency meter signal</td><td>Across FM(+) and SD</td><td>Approximately 5VDC at maximum frequency (without frequency meter)

Pulse width T1: Adjust with C0 (Pr.900)
Pulse cycle T2: Set with Pr.55
(frequency monitor only)</td><td rowspan="4">"SD" is common.</td></tr>
<tr><td>Start signal
Select signal</td><td>Across SD and the following:
STF, STR, RH, RM, or RL(+)</td><td rowspan="3">When open
20 to 30VDC
ON voltage: 1V or less</td></tr>
<tr><td>Reset</td><td>Across RES(+) and SD</td></tr>
<tr><td>Output stop</td><td>Across MRS(+) and SD</td></tr>
<tr><td>Fault signal</td><td>Across A and C
Across B and C</td><td>Moving-coil type
(such as tester)</td><td colspan="2">Electric continuity check *2
<Normal> <Fault>
Across A and C Discontinuity Continuity
Across B and C Continuity Discontinuity</td></tr>
</table>

*1 Use an FFT to measure the output voltage accurately. An FA tester or general measuring instrument cannot measure accurately.
*2 When the setting of *Pr.192 A,B,C terminal function selection* is positive logic.
*3 A digital power meter (designed for inverter) can also be used to measure.

6.2.1 Measurement of powers

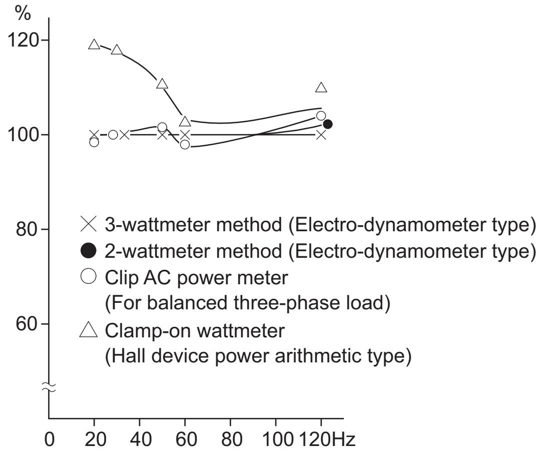
Use electro-dynamometer type meters (for inverter) for the both of drive unit input and output side. Alternatively, measure using electrodynamic type single-phase wattmeters for the both of drive unit input and output side in two-wattmeter or threewattmeter method. As the current is liable to be imbalanced especially in the input side, it is recommended to use the three-wattmeter method.
Examples of process value differences produced by different measuring meters are shown below.
An error will be produced by difference between measuring instruments, e.g. power calculation type and two- or three-wattmeter type three-phase wattmeter. When a CT is used in the current measuring side or when the meter contains a PT on the voltage measurement side, an error will also be produced due to the frequency characteristics of the CT and PT.

[Measurement conditions]
Constant-torque (100%) load, note that 60Hz or more should be constantly output 3.7kW, 4-pole induction motor, value indicated in 3-wattmeter method is 100%.



Example of Measuring Input Power

[Measurement conditions]
Constant-torque (100%) load, note that 60Hz or more should be constantly output 3.7kW, 4-pole induction motor, value indicated in 3-wattmeter method is 100%.



Example of Measuring Output Power

6.2.2 Measurement of voltages and use of PT

(1) Drive unit input side

As the input side voltage has a sine wave and it is extremely small in distortion, accurate measurement can be made with an ordinary AC meter.

(2) Drive unit output side

Since the output side voltage has a PWM-controlled rectangular wave, always use a rectifier type voltmeter. A needle type tester can not be used to measure the output side voltage as it indicates a value much greater than the actual value. A moving-iron type meter indicates an effective value which includes harmonics and therefore the value is larger than that of the fundamental wave. The value monitored on the operation panel is the drive unit-controlled voltage itself. Hence, that value is accurate and it is recommended to monitor values using the operation panel.

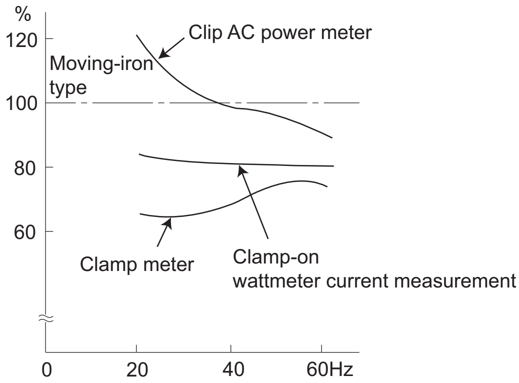
(3) PT

No PT can be used in the output side of the drive unit. Use a direct-reading meter. (A PT can be used in the input side of the drive unit.)

6.2.3 Measurement of currents

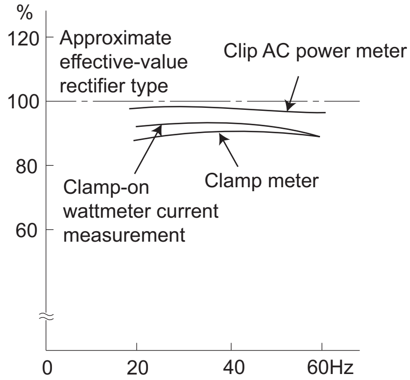
Use moving-iron type meters on the input side of the drive unit, use approximate effective-value rectifier type AC ammeter on the output side.
Since current on the drive unit input side tends to be unbalanced, measurement of three phases is recommended. Correct value can not be obtained by measuring only one or two phases. On the other hand, the unbalanced ratio of each phase of the output side current should be within 10%.
When a clamp ammeter is used, always use an effective value detection type. A mean value detection type produces a large error and may indicate an extremely smaller value than the actual value. The value monitored on the operation panel is accurate if the output frequency varies, and it is recommended to monitor values (provide analog output) using the operation panel.
Examples of process value differences produced by different measuring meters are shown below.

[Measurement conditions]
Value indicated by moving-iron type ammeter is 100%.



Example of measuring input current

[Measurement conditions]
The value indicated by an approximate effective-value rectifier type AC ammeter is 100%.



Example of measuring output current

6.2.4 Use of CT and transducer

A CT may be used in both the input and output sides of the drive unit, but the one used should have the largest possible VA ability because an error will increase if the frequency gets lower.
When using a transducer, use the effective value calculation type which is immune to harmonics.

6.2.5 Measurement of drive unit input power factor

Calculate using effective power and apparent power. A power-factor meter can not indicate an exact value.

$$\text{Total power factor of the drive unit} = \frac{\text{Effective power}}{\text{Apparent power}} = \frac{\text{3-phase input power found by 3-wattmeter method}}{\sqrt{3} \times \text{V (power supply voltage)} \times \text{I (input current effective value)}}$$

6.2.6 Measurement of converter output voltage (across terminals P/+ and N/-)

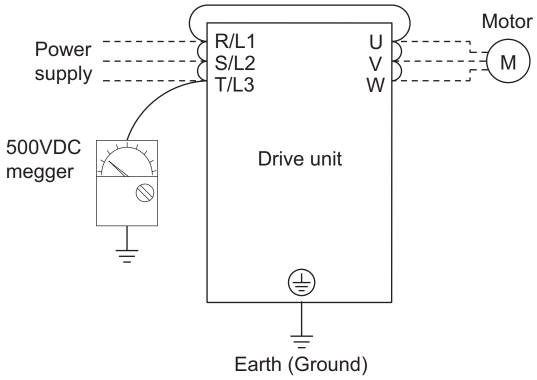
The output voltage of the converter is developed across terminals P/+ and N/- and can be measured with a moving-coil type meter (tester). Although the voltage varies according to the power supply voltage, approximately 270VDC to 300VDC is output when no load is connected and voltage decreases during driving load operation.
When energy is regenerated from the motor during deceleration, for example, the converter output voltage rises to nearly 400VDC to 450VDC maximum.

6.2.7 Measurement of drive unit output frequency

A pulse train proportional to the output frequency is output across the frequency meter signal output terminal FM-SD of the drive unit. This pulse train output can be counted by a frequency counter, or a meter (moving-coil type voltmeter) can be used to read the mean value of the pulse train output voltage. When a meter is used to measure the output frequency, approximately 5VDC is indicated at the maximum frequency.
For detailed specifications of the frequency meter signal output terminal FM, refer to *page 162*.

6.2.8 Insulation resistance test using megger

- For the drive unit, conduct the insulation resistance test on the main circuit only as shown below and do not perform the test on the control circuit. (Use a 500VDC megger.)



NOTE
- **Before performing the insulation resistance test on the external circuit, disconnect the cables from all terminals of the drive unit so that the test voltage is not applied to the drive unit.**
- **For the electric continuity test of the control circuit, use a tester (high resistance range) and do not use the megger or buzzer.**

6.2.9 Pressure test

Do not conduct a pressure test. Deterioration may occur.

MEMO

7 SPECIFICATIONS

This chapter provides the "SPECIFICATIONS" of this product. Always read the instructions before using the equipment.

7.1 Rating

●Three-phase 200V power supply

	Model FR-E720EX-□K	0.1	0.2	0.4	0.75	1.5	2.2	3.7
Output	Rated current (A)	0.8	1.5	3	5	8	11	17.5
Output	Overload current rating	150% 60s, 200% 3s (reference rated motor current, inverse-time characteristics)						
Power supply	Rated input Rated input AC voltage/frequency	Three-phase 200 to 240V 50Hz/60Hz						
Power supply	Permissible AC voltage fluctuation	170 to 264V 50Hz/60Hz						
Power supply	Permissible frequency fluctuation	±5%						
Protective structure		Enclosed type (IP20)						
Cooling system		Self-cooling				Forced air cooling		
Approximate mass (kg)		0.5	0.5	0.7	1.0	1.4	1.4	1.7

7.2 Common specifications

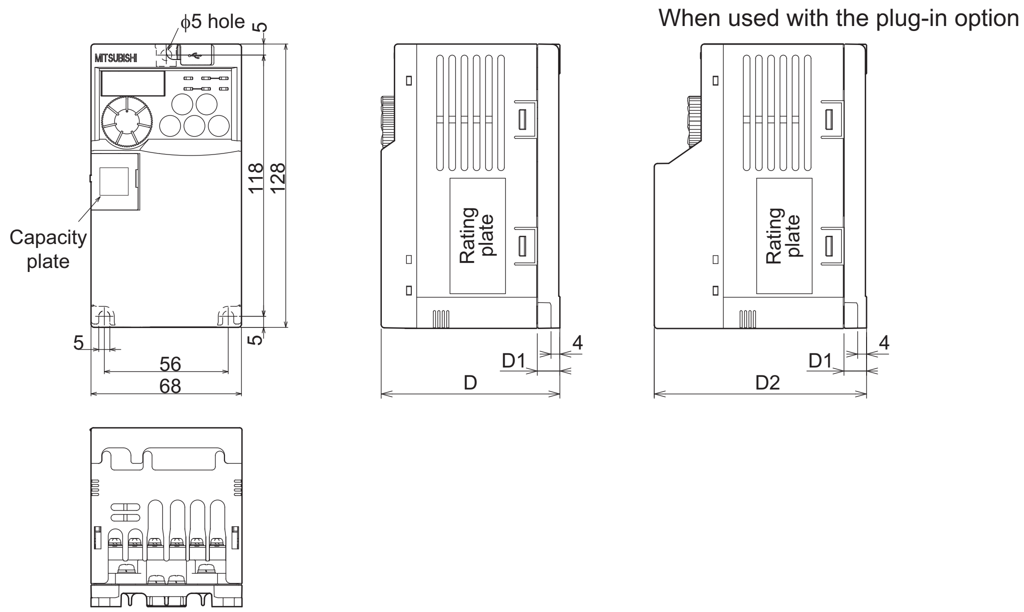
Motor				MM-GKR motor	S-PM geared motor
Control specifications	Control method			PM sensorless vector control (low-speed range: current synchronization operation)	PM sensorless vector control (low-speed range: current synchronization operation)
	Carrier frequency			10kHz (when driving an MM-GKR motor)	5kHz
	Starting torque			200% (initial value)	100% (initial value)
	Torque boost			—	PM control torque boost, DC injection brake torque boost
	Initial magnetic pole detection time			Approx. 0.1s (performed at start, at SON/LX signal ON.)	
	Torque limit operation level			Operation current level can be set (0 to 200% adjustable), whether to use the function or not can be selected.	
	Speed control	Speed fluctuation ratio		±0.05% *2	
		Speed control range		Full speed range (speed ratio at digital input 1:1000)	PM sensorless vector control range 1:10
		Speed setting resolution	Analog input	3r/min/3000r/min (terminal2, 4: 0 to 10V/10-bit) 6r/min/3000r/min (terminal2, 4: 0 to 5V/9-bit) 3r/min/3000r/min (terminal4: 0 to 20mA/10-bit)	
			Digital input	1r/min	
		Analog speed command input		Two terminals Terminal 2: 0 to 10V, 0 to 5V can be selected Terminal 4: 0 to 10V, 0 to 5V, 4 to 20mA can be selected	
		Acceleration/ deceleration time setting		0.01 to 360.00s (acceleration and deceleration can be set individually).	
		Acceleration/ deceleration time pattern		Selectable between the linear acceleration/deceleration and the S-pattern acceleration/deceleration	
		Digital speed command input		Input from the operation panel or parameter unit. Frequency setting increment is selectable.	
	Position control	Command input method		Point table method. Position control by an absolute position command is available after home position return.	—
		Motor internal command resolution		5120 [pulses/rev]	—
		Positioning accuracy		±1.8° (mechanical angle of 200 [pulses/rev] resolution equivalent; input voltage of 200V; and wiring length of 5m or less)	—
	Communication specification			Built-in to the drive unit : RS-485 communication (Mitsubishi inverter protocol, Modbus-RTU communication) Option: CC-Link communication	

Operation specifications	Start signal		Forward and reverse rotation or start signal automatic self-holding input (3-wire input) can be selected.
Operation specifications	Input signal (seven terminals)		The following signals can be assigned to *Pr.178 to Pr.184 (input terminal function selection)* : multi-speed selection, second function selection, terminal 4 input selection, JOG operation selection, external thermal input, drive unit operation enable signal, PU operation external interlock, PID control valid terminal, PU-External operation switchover, pre-excitation, output stop, start self-holding selection, stopper control switchover, P/PI control switchover, forward rotation, reverse rotation command, drive unit reset, PU-NET operation switchover, External-NET operation switchover, command source switchover, proximity dog, servo-on, position control sudden stop, forward stroke end, and reverse stroke end
Operation specifications	Operational functions		Upper/lower limit setting, speed jump operation, external thermal relay input selection, forward/reverse rotation prevention, remote setting, second function, multi-speed operation, regeneration avoidance, operation mode selection, PID control, computer link operation (RS-485), Modbus-RTU
Operation specifications	Output signal	Operating status: Open collector output (Two terminals) Relay output (One terminal)	The following signals can be assigned to *Pr.190 to Pr.192 (output terminal function selection)* : drive unit operation, speed reached, overload alarm, speed detection, regenerative brake prealarm, electronic thermal relay function prealarm, drive unit operation ready, output current detection, zero current detection, PID lower limit, PID upper limit, PID forward/reverse rotation output, electromagnetic brake interlock, stroke limit warning, fan alarm *1, heatsink overheat prealarm, operation ready 2, in-position, travel completed, during PID control, rough match, home position return failure warning, position detection, position command creating, home position return completed, 24V external power supply operation *3, during retry, life alarm, fault output 3, current average value monitor, maintenance timer alarm, remote output, alarm output, and fault output
Operation specifications	Output signal	For meter: Pulse train output (Max. 2.4kHz: one terminal)	The following signals can be assigned to *Pr.54 FM terminal function selection* : rotation speed (output frequency), output current (steady), output voltage, speed setting value (frequency setting value), converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, output power, reference voltage output, motor load factor (torque monitor), ideal speed command, speed command, PID set point, PID measured value, motor thermal load factor, and drive unit thermal load factor Pulse train output (1440 pulses/s/full scale)
Indication	Operation panel Parameter unit (FR-PU07)	Operating status	The following operating status can be displayed: rotation speed (output frequency), output current (steady), output voltage, speed setting value (frequency setting value), converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, output power, position pulse, cumulative energization time, actual operation time, motor load factor (torque monitor), position command, ideal speed command, speed command, cumulative power, PID set point, PID measured value, PID deviation, drive unit I/O terminal monitor, motor thermal load factor, and drive unit thermal load factor.
Indication	Operation panel Parameter unit (FR-PU07)	Fault record	Fault record is displayed when a fault occurs. Past 8 fault records (output voltage/current/frequency/cumulative energization time right before the fault occurs) are stored
Indication	Operation panel Parameter unit (FR-PU07)	Interactive guidance	Function (help) for operation guide *4
Protective/warning function		Protective functions	Overcurrent during acceleration, overcurrent during constant speed, overcurrent during deceleration, overvoltage during acceleration, overvoltage during constant speed, overvoltage during deceleration, drive unit protection thermal operation, motor protection thermal operation, heatsink overheat, input phase failure *4, stop by the torque limit, output side earth (ground) fault overcurrent at start *4, output phase failure, external thermal relay operation *4, option fault *5, parameter error, PU disconnection, retry count excess *5, CPU fault, brake transistor alarm, inrush resistance overheat, analog input error, USB communication error, loss of synchronism detection, overspeed occurrence, speed deviation excess detection, excessive position fault, acceleration rate error, internal board fault, internal circuit fault
Protective/warning function		Warning functions	Fan alarm *1, overcurrent torque limit, overvoltage stall prevention, PU stop, parameter write error, regenerative brake prealarm *4, electronic thermal relay function prealarm, maintenance output *5, undervoltage, home position return setting error *5, home position return uncompleted, operation panel lock, password locked *5, drive unit reset, 24V external power supply operation, stroke limit warning
Environment	Surrounding air temperature		-10°C to +50°C (non-freezing) *6
Environment	Ambient humidity		90%RH or less (non-condensing)
Environment	Storage temperature *7		-20°C to +65°C
Environment	Atmosphere		Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)
Environment	Altitude/vibration		Maximum 1000m above sea level, 5.9m/s ^{2} or less at 10 to 55Hz (directions of X, Y, Z axes)

*1 This function is not available for the FR-E720EX-0.1K to 0.75K, which is not equipped with a cooling fan.
*2 During the load fluctuation of 0 to 100%
*3 This function is available only when used with FR-E7DS. *(Refer to page 316)*
*4 This operation guide is only available with option parameter unit (FR-PU07).
*5 This protective function does not function in the initial status.
*6 When using the drive units at the surrounding air temperature of 40°C or less, the drive units can be installed closely attached (0cm clearance).
*7 Temperatures applicable for a short time, e.g. in transit.

7.3 Outline dimension drawings

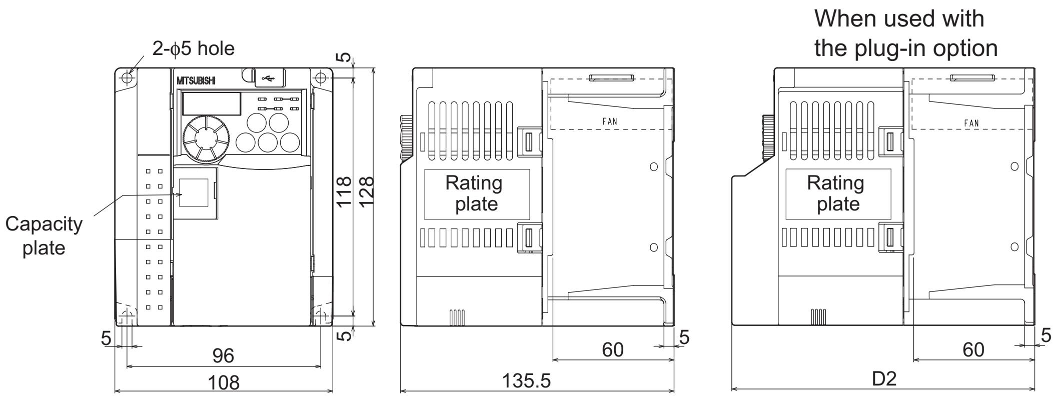
●FR-E720EX-0.1K to 0.75K

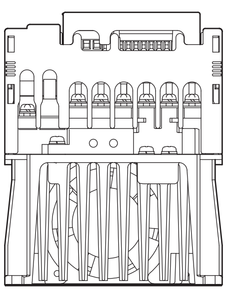


Drive Unit Model	D	D1	D2	
			When used with FR-A7NC E kit	When used with FR-E7DS
FR-E720EX-0.1K, 0.2K	80.5	10	97.6	108
FR-E720EX-0.4K	112.5	42	129.6	140
FR-E720EX-0.75K	132.5	62	149.6	160

(Unit: mm)

●FR-E720EX-1.5K, 2.2K





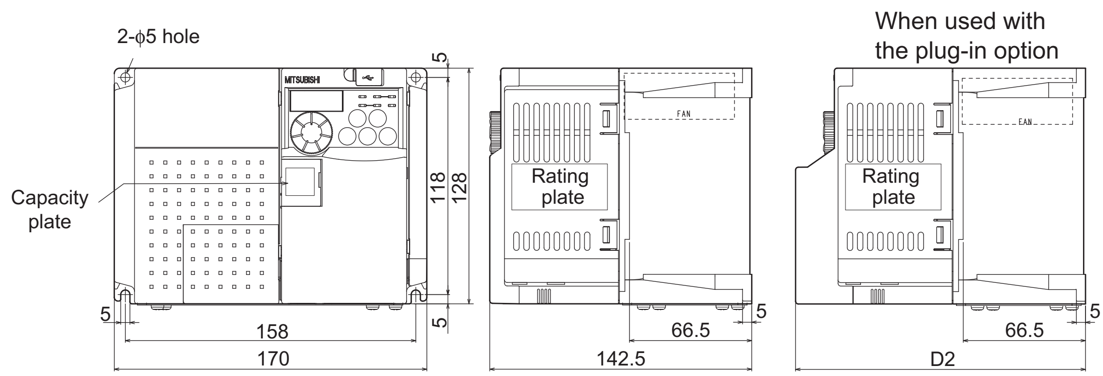
D2	
When used with FR-A7NC E kit	When used with FR-E7DS
152.6	163

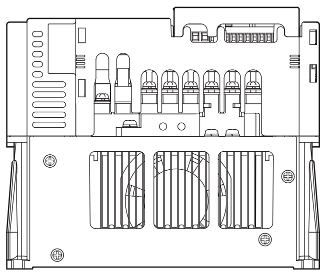
(Unit: mm)

SPECIFICATIONS

7

●FR-E720EX-3.7K



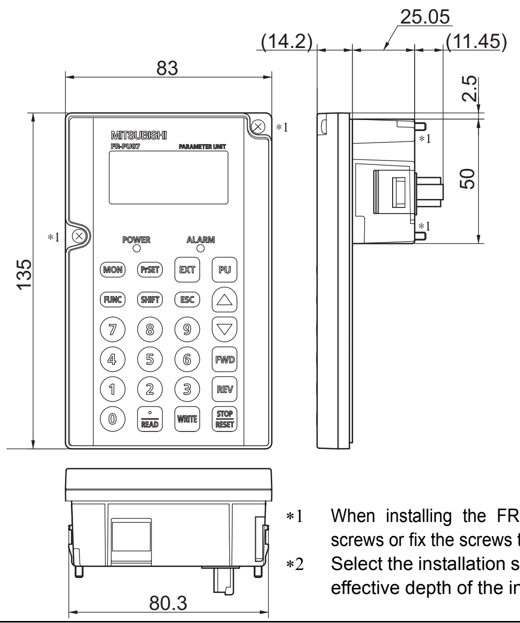


D2	
When used with FR-A7NC E kit	When used with FR-E7DS
159.6	170

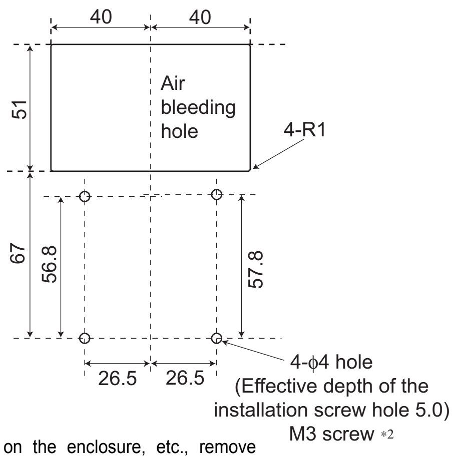
(Unit: mm)

●Parameter unit (option) (FR-PU07)

<Outline drawing>



<Enclosure cut dimension drawing>



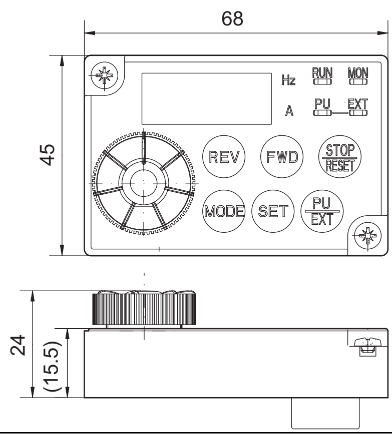
*1 When installing the FR-PU07 on the enclosure, etc., remove screws or fix the screws to the FR-PU07 with M3 nuts.

*2 Select the installation screw whose length will not exceed the effective depth of the installation screw hole.

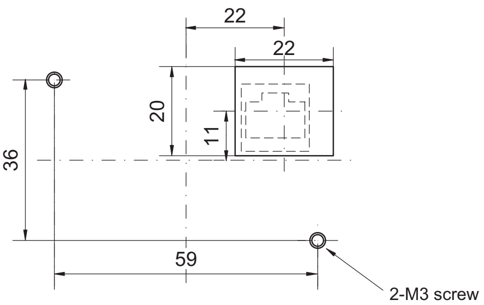
(Unit: mm)

●Enclosure surface operation panel (option) (FR-PA07)

<Outline drawing>



<Enclosure cut dimension drawing>



(Unit: mm)

7.4 Specifications of the dedicated PM motor [MM-GKR motor] GKR

7.4.1 Motor specifications

MM-GKR 1 3 □ □ □

Symbol	Rated output (kW)
1 to 7	Refer to the following section.

Symbol	Rated speed (r/min)
3	3000

Symbol	Oil seal
—	Without
J	With *1*2

Symbol	Reduction gear *3
—	Without
G0	For general industrial machine (flange mounting)

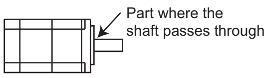
Symbol	Shaft end
—	Standard (straight shaft)
K	Key shaft (with key) *3
D	D-cut shaft *3

*1 The reduction gear equipped models do not have the oil seal.
*2 The oil seal model has an outline dimension different from the standard motor.
For the details, please contact your sales representative.
*3 For the applicable models and detailed specifications, refer to the sensorless servo catalog.

●Standard specifications

Motor model	MM-GKR□□	13	23	43	73
Compatible drive unit	FR-E720EX-□K	0.1	0.2	0.4	0.75
Power supply capacity (kVA) *2		0.3	0.5	0.9	1.3
Continuous characteristic	Rated output (kW)	0.1	0.2	0.4	0.75
	Rated torque (N·m) *3	0.32	0.64	1.3	2.4
Maximum torque (N·m)		0.64	1.3	2.5	4.8
Rated speed (r/min)		3000			
Maximum speed (r/min)		3000			
Instantaneous permissible speed (r/min)		3450			
Power rate at continuous rated torque (kW/s)		15.0	21.7	43.7	46.0
Number of poles		10			
Rated current (A)		0.65	1.08	1.94	3.34
Maximum current (A)		1.3	2.2	3.9	6.7
Moment of inertia ($\times10^{-4}$kg·m^2)		0.0676	0.187	0.371	1.24
Recommended load inertia moment ratio *4		10 times or lower			
Speed/position detector		None			
Oil seal		Not available (the oil seal model is also available. (MM-GKR_J))			
Heat-resistant class		130 (B)			
Structure		Totally enclosed self-cooling			
Protective structure		IP65 *5			
Environment *7	Surrounding air temperature	0°C to +40°C (non-freezing), in storage: -15°C to +70°C (non-freezing)			
	Ambient humidity	80%RH or less (non-condensing), in storage: 90%RH or less (non-condensing)			
	Atmosphere	Indoors (avoid direct sunlight), free from corrosive gas, flammable gas, oil mist, dust and dirt			
	Altitude	Maximum 1,000m above sea level			
	Vibration *6	X: 49m/s^2, Y: 49m/s^2			
Vibration rank		V10 *8			
Permissible load on the shaft *9	L (mm)	25	30	30	40
	Radial (N)	88	245	245	392
	Thrust (N)	59	98	98	147
Mass (kg)		0.4	0.77	1.3	2.7

*1 The above characteristics apply when the rated AC voltage is input from the drive unit (*Refer to page 303*). Output and rated motor speed are not guaranteed when the power supply voltage drops.
*2 The power supply capacity varies with the value of the power supply side drive unit impedance (including those of the input reactor and cables).
*3 For a machine that produces unbalanced torque, such as a lift axis, the recommended unbalanced torque is the 70% of the rated torque or lower.
*4 This is the ratio of the moment of load inertia to the moment of motor inertia under position control. If the load inertia moment ratio exceeds the described value, please contact your sales representative.
*5 This excludes the part where the shaft passes through. For the reduction gear equipped model, the protective structure is equivalent to IP44.



SPECIFICATIONS

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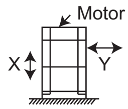
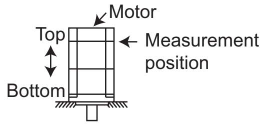
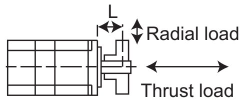
*6 X indicates the direction of the motor's output shaft, and Y indicates the direction vertical to the motor's output shaft. Usually, the indicated value is of the non-load side bracket where the vibration is the greatest.
Bearing is subject to fretting while the motor is stopped. Suppress the vibration to about the half of the permissible value.



*7 The standard motor may not be used under the condition where it is constantly exposed to oil mist, oil, or water. For the details, please contact your sales representative.
*8 "V10" means that the vibration amplitude of the single motor is 10μm or lower. The following figure shows the installation orientation of the motor and measurement position at the vibration degree measurement.



*9 For the permissible load on the shaft, refer to the following figure. On the shaft, do not apply a load exceeding the value in the table.
Each value in the table shows the permissible value for the single load application.



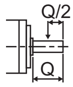
L: Distance from the flange mounting surface to the center of the load

●Reduction gear equipped model specifications
Reduction gear equipped model for general industrial machines: G0

Model	Output (W)	Reduction ratio	Actual reduction ratio	Moment of inertia J ($\times 10^{-4}$kg·m^2) *1	Permissible load inertia moment ratio *2 (calculation at motor shaft)	Mass (kg)	Permissible load on the shaft *5	
							Permissible radial load (N)	Permissible thrust load (N)
MM-GKR13G0	100	1/5	42/221	0.0720	10 times or lower of the moment of motor inertia	1.3	150	200
		1/12	9/104	0.0706		1.3	240	320
		1/20	12/247	0.0703		1.3	370	450
		1/30	24/713	0.0768		2.4	500	500
MM-GKR23G0	200	1/5	44/217	0.222		2.8	330	350
		1/12	48/589	0.204		2.8	710	720
		1/20	32/651	0.201		2.8	780	780
		1/30	24/713	0.200		2.8	780	780
MM-GKR43G0	400	1/5	15/77	0.406		3.2	330	350
		1/12	9/110	0.390		3.2	710	720
		1/20	9/189	0.399		4.3	760	780
		1/30	12/351	0.398		4.3	760	780
MM-GKR73G0	750	1/5	19/95	1.37		5.5	430	430
		1/12	40/475	1.32		5.5	620	620
		1/20	14/285	1.29		7.3	970	960
		1/30	25/722	1.28		7.3	970	980

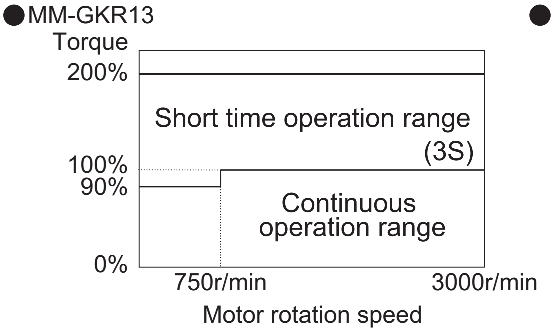
Item	Specifications
Installation method	Flange mounting
Installation orientation	Any orientation
Lubrication method	Grease (already filled)
Rotation direction of output axis	Same as that of the motor output axis
Backlash *4	60 minutes or less at the output shaft of the reduction gear
Maximum torque	Twice of the rated torque (For the rated torque, refer to page 307)
Permissible speed (motor axis)	3000r/min (Instantaneous permissible speed: 3450r/min)
IP rating	Equivalent to IP44
Vibration resistance	X: 29.4 m/s^2, Y: 29.4 m/s^2
Reduction gear efficiency *3	80% or higher

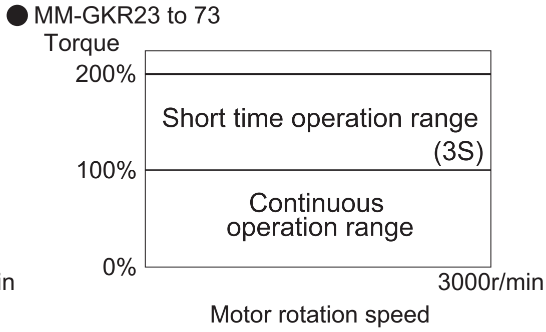
*1 This value is a value at the shaft of the motor with a reduction gear.
*2 If the value exceeds the described value, please contact your sales representative.
*3 The reduction gear efficiency differs depending on the reduction ratio. Additionally, the reduction gear efficiency varies depending on operating conditions, such as the output torque, rotation speed, and temperature.
The value in the table is a typical value for the rated torque at the rated speed and at a room temperature, but not a guaranteed value.
*4 The following conversion formula is used for the unit conversion of the backlash: 1 minute = 0.0167°.
*5 The permissible radial load is the value at the center of the output shaft of the reduction gear. On the shaft, do not apply a load exceeding the value in the table. Each value in the table shows the permissible value for the single load application.



Q: Shaft length

7.4.2 Motor torque characteristic





- When the input voltage is low, the torque may be reduced.
- The continuous operation torque becomes 80% at 6r/min or lower.
- When driving the motor under high load in low-speed range (especially at 6 r/min or lower), the protective function by electronic thermal O/L relay (E.THT or E.THM) may be activated and the short time operation range torque may not be generated.

7.5 Specifications of the dedicated PM motor [S-PM geared motor] S-PM

7.5.1 Motor specifications

●Model names of S-PM geared motors

GV-S*1 0.4kW 150r/min 200V

Series	Output	Speed	Voltage
GV-S (parallel shaft, fixed load)	0.1 to 2.2kW	Speed at output shaft *2 (3000r/min / nominal reduction ratio)	200V class
GV-SSY (right-angled shaft, fixed load)			
GV-SHY (right-angled shaft, medium load)			

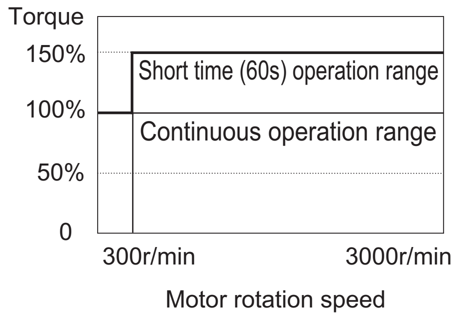
*1 For the model names of the flange types and brake-equipped types, refer to the catalog.
*2 For the detail of the output-shaft rotation speed (reduction ratio), refer to the catalog.

Motor model	GV-□□kW	0.1	0.2	0.4	0.75	1.5	2.2
Compatible drive unit	FR-E720EX-□K	0.2	0.4	0.75	1.5	2.2	3.7
Power supply system capacity (kVA) *4		0.4	0.7	1.2	2.1	4.0	5.5
Continuous characteristic *1	Rated output (kW)	0.1	0.2	0.4	0.75	1.5	2.2
	Rated torque (N•m) *2	0.32	0.64	1.27	2.39	4.78	7.00
Rated speed (r/min) *3		3000					
Maximum speed (r/min) *3		3000					
Number of poles		4					6
Maximum torque		150% 60s					
Rated current (A)		0.55	1.05	1.6	2.8	5.5	9.4
Structure		Totally enclosed self-cooling				Totally-enclosed fan-cooled	
Protective structure		IP44 (indoors), IP44 (outdoors) for semi-standard models					
Environment	Surrounding air temperature and humidity	0°C to +40°C (non-freezing), 90RH or less (non-condensing)					
	Vibration	4.9m/s^2 (0.5G) for continuous operation, 9.8m/s^2 (1G) for instantaneous operation					

*1 The above characteristics apply when the rated AC voltage is input from the drive unit *(Refer to page 302)*. Output and rated motor speed are not guaranteed when the power supply voltage drops.
*2 The value at the motor shaft. The torque at the output shaft changes according to the reduction ratio and the reduction gear efficiency.
*3 The value at the motor shaft. The speed of the output shaft changes according to the reduction ratio.
*4 The power supply capacity varies with the value of the power supply side drive unit impedance (including those of the input reactor and cables).

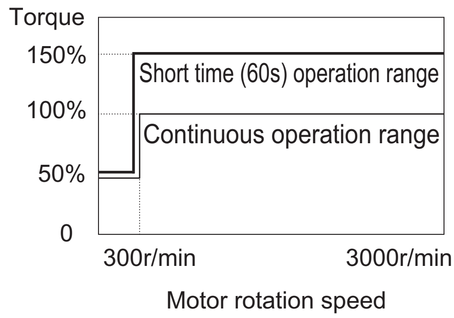
7.5.2 Motor torque characteristic

<<Initial setting(*Pr.785* =9999(=100%))>>



- The short-time torque can be up to 100% in low speed (300r/min) operation, but continuous operation is not available.
- When the input voltage is low, the torque may be reduced.
- The operatable speed range at constant torque is 300r/min to 3000r/min.
  Continuous operation cannot be performed in 300r/min or less.

<<When *Pr.785* = 50%>>



- Setting *Pr.785 PM control torque boost* = 50% or less* will enable continuous operation at 300r/min or lower. However, the keep the short-time torque to *Pr.785* setting or lower.
  * For FR-E720EX-1.5K or lower, it is 80% or lower.
- When the input voltage is low, the torque may be reduced.
- The operatable speed range at constant torque is 300r/min to 3000r/min.

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MEMO

APPENDIX

**This chapter provides the "APPENDIX" of this product.
Always read the instructions before using the equipment.**

Appendix1 Precautions for use of the MM-GKR motor (Precautions when replacing servo) GKR

The control method is PM sensorless vector control. Several restrictions are applied because the encoder is not provided among other reasons.
When using this drive unit and a sensorless PM motor, always check the machine operation in the actual system.

Restrictions

- In positioning operation, the home position is cleared at servo-OFF or power-OFF because no sensor (encoder) is provided. Always perform the home position return again.
- In a low-speed operation or at a stop, torque ripples or uneven rotation occur. (The operating conditions and parameter setting affect these.)
- The positioning accuracy is ±1.8°, and the speed control range is 1:1000. However, a slight vibration at a stop or uneven rotation may occur due to torque ripples. In such a case, ±1.8° is the average positioning accuracy, and 1:1000 is the average speed control range.
  The maximum wiring length to the motor is 30m. However, to ensure the positioning accuracy of ±1.8°, the wiring length must be within 5m and the power supply voltage must be between 200 and 220V.
- The best response level in the middle-speed range or higher is 100Hz, but the response level is decreased (to about 50Hz) in the low-speed range (0.1kW: 600r/min or lower or 0.2 to 0.75kW: 300r/min or lower).
- Sensors such as an encoder are not provided. When mechanical protection related to positioning is necessary, install such protection externally.
- No dynamic brake circuit is built in. Prepare a dynamic brake externally if needed.
- Position deviation or an error may occur due to sudden deceleration of about 0.05 second or lower (3000r/min → 0r/min) or the impact torque exceeding 100% around the zero speed. Check the operation, and adjust the deceleration time, speed response level, and model adaptive control gain as necessary to prevent position deviation or errors.

Motor structure (compared with the servo motor HG-KR)

- The bracket at the non-load side of MM-GKR13 is larger. (Servo motor: □40, MM-GKR: □43)
- [Reduction gear equipped model] The lengths of the installation bolts are different.
- [Reduction gear equipped model] The shapes of the gear heads are different.

Motor specifications (compared with the servo motor HG-KR)

- The 50W capacity model is not available.
- The continuous rated torque is 90% at 750r/min or lower of MM-GKR13.
- The maximum torque is smaller. (Servo motor: 350%, MM-GKR: 200%)
- The maximum rotation speed is slower. (Servo motor: 6000r/min, MM-GKR: 3000r/min)
- The moment of inertia is different. (For the model without a reduction gear, the moment of inertia is lower by 0 to 16%.
- The recommended load inertia moment ratio (under position control) is lower. (Servo motor: 17 to 26 times or lower, MM-GKR: 10 times or lower)
- Although no sensor (encoder) is provided, the IP rating and environment conditions are the same.
  ∗ Note that problems related to the sensor (encoder) do not occur.
- [Reduction gear equipped model] Reduction gear equipped model has the IP rating of IP44.

Others

- The available power supply input is three-phase 200 to 240V only.
- Only the electronic thermal O/L relay is provided as the temperature protective function. (Servo motor: Electronic thermal O/L relay and encoder thermistor, MM-GKR: Electronic thermal O/L relay)
- In the low-speed range (750r/min or lower for the 0.1kW, 300r/min or lower 0.2 to 0.75kW), high-frequency tone is heard because of the high frequency superposition control.
- The maximum wiring length between the drive unit and motor is 30m.

Item		Sensorless servo MM-GKR motor	AC servo	
			JN series	J4 series
Control mode		Speed control Position control	Speed control Position control Torque control	Speed control Position control Torque control
Encoder		Not used	Used	Used
Initial magnetic pole detection		Required (detection time: about 0.1s)	Not required because the encoder is provided.	Not required because the encoder is provided.
Speed fluctuation ratio (Load fluctuation 0 to 100%)	Digital input	±0.05% or lower	±0.01% or lower	±0.01% or lower
	Analog input (Surrounding air temperature: 25±10°C)	±0.5% or lower	-	±0.2% or lower
Speed control range		1: 1000	1: 5000 (internal speed command)	1: 2000 (analog speed command) 1: 5000 (internal speed command)
Command resolution/encoder resolution		5120 pulses/rev	131072 pulses/rev (incremental)	4194304 pulses/rev (absolute)
Positioning accuracy		±1.8°	-	-
Maximum torque		200%	300%	350%
Dynamic brake		None (must be provided externally)	Built-in	Built-in

Differences with AC servo

Appendix2 Precautions for use of the S-PM geared motor S-PM

Installation

- When a suspension tool is provided for a motor, carry the motor using the suspension tool.
- When a motor is used for a lift, install a safety device on the machine side. There is a risk that a lifted cargo, etc. may fall off.
- If any oil component, grease, etc. may leak out in case of a fault and adversely affect the environment adversely, prepare an oil pan (oil catcher) or other device to prevent leakage of oil or grease.
- Provide a safety cover for components such as belts, chains, or gears.
- If small pieces of foreign matter enters through or water causes rust at the oil seal section of the output shaft, grease may leak out. Take necessary precautions. Do not use the motor in a place that may be wet with water.

Operation

- The motor shaft may move at start.
- Do not use the motor in an application in which an excessive impact torque is generated during stopping (example: stop-on contact at high speed). Doing so may damage the motor.
- Always stop the operation and inspect the motor when any abnormal noise or vibration is generated during operation, or when the specified characteristics cannot be achieved.
- In the case of variable load, a sound generated by the effect of end play of the motor shaft may be heard, but it will not cause any performance problem.

Brake

- When using a motor with a brake, always adopt the separate braking method or the direct current (quick) braking method for the brake wiring connection.
- Do not operate a manual releasing mechanism of the brake while an object is suspended. There is a risk that a lifted cargo, etc. may fall off.
- Before starting operation of a geared motor with a one-touch manual releasing brake, always fix the releasing lever on the lever receiver.
- For a lift application, adopt the direct current (quick) braking method for the circuit.
- In the initial use condition, the specified brake torque may not be achieved for the reason of the friction surfaces. In such a case, repeat turning ON/OFF of the brake with a lightest possible load as a running-in process for the friction surfaces.
- A lining rubbing sound may be generated because of the brake structure, but it will not affect performance.
- For the connection with the separate braking method, it is necessary to match the operation timings between the motor and the brake. If the operation timings are different, there is a risk of falling, crashing, or brake damage.

Appendix3 Specification change

For the production date of the drive unit, check the serial number printed on the rating plate or on package. For how to find the SERIAL, refer to *page 2*.

●Changed functions

(1) The following functions are available for the drive units manufactured in January 2014 or later.

Item	Changed functions
Compatibility with S-PM geared motors	The FR-E720EX-0.2K to 3.7K support the S-PM 0.1 kW to 3.7 kW motors.
Compatibility with a plug-in option	FR-E7DS
Added parameters	*Pr.148, Pr.149, Pr.244, Pr.658, Pr.785, Pr.795, Pr.998, Pr.999*
Changed parameter setting ranges	Addition of setting value "9999" of *Pr.22* Addition of setting values "25, 125" of *Pr.190 to Pr.192* Addition of setting value "245" of *Pr.997*
Added alarm	EV 24V external power supply operation

Appendix4 Index

REVISIONS

*The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Dec. 2013	IB(NA)-0600507ENG-A	First edition
Jun 2014	IB(NA)-0600507ENG-B	Addition • FR-E720EX-1.5K to 3.7K • Compatibility with S-PM geared motors • *Pr.148, Pr.149, Pr.244, Pr.658, Pr.785, Pr.795, Pr.998, Pr.999* • Setting value "9999" of *Pr.22* • Setting values "25, 68, 125, 168" of *Pr.190 to Pr.192* • Setting value "245" of *Pr.997* • Fault displays EV and E.5 Modification • Motor specifications ·Power rate at continuous rated torque and moment of inertia for standard MM-GKR motors ·Mass for reduction gear equipped MM-GKR motors

⚠ For Maximum Safety

- Mitsubishi drive units are not designed or manufactured to be used in equipment or systems in situations that can affect or endanger human life.
- When considering this product for operation in special applications such as machinery or systems used in passenger transportation, medical, aerospace, atomic power, electric power, or submarine repeating applications, please contact your nearest Mitsubishi sales representative.
- Although this product was manufactured under conditions of strict quality control, you are strongly advised to install safety devices to prevent serious accidents when it is used in facilities where breakdowns of the product are likely to cause a serious accident.
- Please do not use this product for loads other than three-phase induction motors.

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